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ERRATA

Page 4 line 23 for "Shell OS 2064" read "Shell OS 2046"

,, 73 line 5 for "octene" read "octane"

,, 89 line 7 for "L 13/69" read "L 13/59"

,, 111 8 lines from end for "Linquist" read "Lindquist"

,, 132 line 2 for "gm." read "mg."

COMMONWEALTH INSTITUTE OF ENTOMOLOGY.

REVIEW
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APPLIED ENTOMOLOGY.

SERIES B.

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TAHORI (A. S.). **Diaryl-trifluoromethyl-carbinols as Synergists for DDT against DDT-resistant House Flies.**—*J. econ. Ent.* **48** (1955) no. 6 pp. 638–642, 11 refs. Menasha, Wis., 1956.

Possible synergists for DDT against *Musca domestica vicina* Macq. were tested by topical application to the ventral thorax of females. The flies belonged to two Israel strains of which one (T) was about 15 times as resistant to DDT as a normally susceptible strain of *M. d. domestica* L. and the other (R) was initially three times as resistant as T, but had become 14 times as resistant as a result of selection for nine laboratory generations. In tests against strain T of 29 compounds structurally related to DDT, the only ones that showed appreciable synergistic activity with it were carbinols, ethanes or esters that contained the trifluoromethyl group. The most active was bis(p-chlorophenyl)-trifluoromethyl-carbinol, which was, by itself, one-third as toxic as DDT. When it was used at a ratio of 1:10 with DDT, the amount of DDT needed to give 50 per cent. mortality could be reduced from 3 to 0·2 μg. per fly. Synergistic activity was reduced by replacement of the chlorine atoms by bromine, fluorine, methoxy, nitro, methyl or ethoxy, by reduction of the carbinol to the corresponding ethane or by its esterification, and destroyed by a prolongation of the aliphatic chain, or by elimination of one p-chlorophenyl group.

Bis(p-chlorophenyl)-trifluoromethyl-carbinol was also more active than bis(p-chlorophenyl)chloromethane, 1,1-bis(p-chlorophenyl)ethane and bis(p-chlorophenyl)-methyl-carbinol (DMC), which were known to be synergists for DDT [*R.A.E.*, B **41** 74]. Combined with DDT at 1:10, it formed a mixture that was 15 and 127 times as toxic to strains T and R, respectively, as DDT alone, whereas the other three known synergists formed mixtures that were 10, 7·5 and 6 times as toxic as DDT to strain T and 93, 70 and 46 times to strain R. In a test of lasting effectiveness, made by exposing the flies on treated filter papers for one hour, DDT at 200 mg. per sq. ft. gave 85 per cent. mortality after three days but only 20 per cent. after seven days. The addition of 20 mg. bis(p-chlorophenyl)-trifluoromethyl-carbinol made a deposit that gave 92 per cent. mortality after 55 days. In a comparative test, it was more effective than the three known synergists in prolonging the effectiveness of DDT deposits.

The mode of action of the new synergists has not yet been determined, but a preliminary experiment in which DDT was applied to the ventral

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thorax and bis(p-chlorophenyl)-trifluoromethyl-carbinol to the head of flies with good results proved that the synergistic action was not due to enhanced penetration.

KELLER (J. C.) & WILSON (H. G.). **Granular Baits for the Control of House Flies.**—*J. econ. Ent.* **48** (1955) no. 6 pp. 642–643, 4 refs. Menasha, Wis., 1956.

Because liquid poison baits for the control of *Musca domestica* L. [*R.A.E.*, B **42** 3; **43** 26, 102; **44** 175] may dry rapidly in hot weather or soak into absorbent surfaces, and dry sugar baits [**44** 73–74] may dissolve on contact with moist floors or soil or through high relative humidity and be absorbed, the suitability of insoluble granular carriers was studied. The baits were sifted lightly from a shaker-top jar in situations in which flies were congregating. Populations of *M. domestica* were estimated from the numbers feeding on cloth strips saturated with a solution of malt and water, and estimates of the effectiveness of the treatments were based on differences between fly counts before treatment and ten minutes and four and 24 hours after it.

The following is based on the authors' summary of the results. Baits of maize meal containing 10 per cent. granulated sugar and 2 per cent. malathion or 1 per cent. Diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl thiophosphate] were tested on garbage and rubbish heaps in a substandard section of Orlando, Florida. The malathion bait gave satisfactory control (83 per cent. in four and 24 hours) after one treatment, and maintained excellent control (93 per cent. or more) with daily applications during a test period of four days. The Diazinon bait gave excellent control (91 and 90 per cent.) ten minutes and four hours after the second treatment, but five treatments were necessary to give a satisfactory reduction after 24 hours. In unscreened dairy barns, single applications of baits containing 2 per cent. malathion, 2 per cent. groundnut oil and 10 per cent. powdered sugar in sand or maize meal or mixtures of both in various proportions were highly effective, giving average control of 92 per cent. or more after 24 hours. A bait containing 2 per cent. Chlorthion [O,O-dimethyl O-3-chloro-4-nitrophenyl thiophosphate] and 10 per cent. powdered sugar on sand gave 98 per cent. reduction after 24 hours, but one containing 1 per cent. Chlorthion and 10 per cent. honey on maize meal gave only 56 per cent. The rate of application in the dairy barns was about 1 gm. per 20 sq. ft.

GILL (G. D.). **Filth Flies of Central Alaska.**—*J. econ. Ent.* **48** (1955) no. 6 pp. 648–653, 1 map, 9 refs. Menasha, Wis., 1956.

A list is given of the species of Diptera taken, mostly in the spring and summer of 1953, during random collecting or on garbage dumps or in traps baited with human excrement, ox liver, carrion, etc., in widely scattered districts in Alaska. The locality, season and attractant are shown in each case. Calliphorids and Muscids (including Anthomyiids) greatly outnumbered other flies. In the trap catches, they comprised, respectively, 2,487 and 1,998 of the 4,682 flies taken on excrement and 30,798 and 700 of the 31,606 taken on liver and carrion. *Phormia* (*Protophormia*) *terraenovae* R.-D., of which over 30,700 examples were trapped, was by far the most abundant and widespread blowfly. *Musca domestica* L. was not taken, although it has been recorded from Alaska in the past.

GREENBERG (B.). **Fecundity and Cold Survival of the House Fly.**—*J. econ. Ent.* **48** (1955) no. 6 pp. 654–657, 1 fig., 15 refs. Menasha, Wis., 1956.

The following is almost entirely the author's summary of experiments in Kansas with a local strain of *Musca domestica* L. Pairs of house-flies kept in small cages where they were visually isolated from all other house-flies, compared well regarding fecundity and length of life with controls similarly housed within larger cages in which flies were numerous [*cf. R.A.E.*, B **4** 62]. A general decline in egg production with age was noted among the paired flies. When larvae reared to the third instar at 36°C. [96·8°F.] or 25–28°C. [77–82·4°F.] were then exposed to 7°C. [44·6°F.] for six days, those reared at the higher temperature suffered a significantly higher mortality, possibly as a result of starvation due to immobility. Prolonged cooling (at 7°C.) of pupae previously reared at 25–28°C. resulted in considerable mortality before the 16th day and no survivors after the 38th day. Of 13 adults remaining from a larger number maintained outdoors during the late autumn, seven survived a period of 44 hours when the maximum temperature was −1·2°C. [29·84°F.] and the minimum was −8·5°C. [16·7°F.]. Oviposition occurred two days after return to room temperature. A tabular summary of data on house-fly fecundity compiled from the work of various authors is included.

DAVIDOW (B.) & LAUG (E. P.). **A Surface Aliquot masking Technique for the Bioassay of Lindane.**—*J. econ. Ent.* **48** (1955) no. 6 pp. 659–661, 1 fig., 5 refs. Menasha, Wis., 1956.

It is shown by the experiments described that the extent of contamination of surfaces in buildings by vaporised γ BHC (lindane) can be assayed from the mortality of house-flies [*Musca domestica* L.] exposed to them, provided that this mortality is within the range of 20–80 per cent., and so comparable with that obtained in standards exposed to known deposits. Batches of 75 flies are exposed on surfaces under glass dishes enclosing an area of 74 sq. cm., and their mortality from a high deposit is reduced to the necessary figure by masking part of the test area with adhesive cellophane tape. The principle of the method is that, within the limits of the assay, a given quantity of insecticide gives the same mortality percentage irrespective of the size of the area over which it is distributed. The method is reasonably accurate even when the area on which the flies are exposed to the insecticide is reduced to 1 sq. cm.

GUYER (G.) & HUTSON (R.). **A Comparison of Sampling Techniques utilized in an ecological Study of aquatic Insects.**—*J. econ. Ent.* **48** (1955) no. 6 pp. 662–665, 1 graph, 19 refs. Menasha, Wis., 1956.

The number and species of aquatic insects (particularly midges) present in water are a useful indication of pollution. Since most aquatic insects can be identified accurately in the adult stage, adult trapping devices would apparently be useful for obtaining such indications. Two adult sampling devices were compared in an investigation made in two localities in Michigan in 1952 and 1953. One was an inverted funnel of sheet metal arranged so that a jar could be fastened to the top. It was made in two sizes, covering areas of 0·5 and 1 sq. yard, and was either put on the bottom of the pond or suspended over the bottom. The second type of trap was a floating tent consisting of a wooden frame that enclosed an area of 0·5 sq. yard and was covered on the sides with cotton cloth and on top with a transparent plastic

hardware cloth. Over 10,000 insects were classified from 626 samples caught in the traps, and the catches are tabulated by tribes or higher groups. For comparison, 338 bottom deposit collections of immature stages were made.

The following is substantially the authors' summary of the findings. The tent and funnel traps were equally successful in making quantitative and qualitative estimates of all taxonomic groups taken in adult samples except Ceratopogonids (Heleids) and Ephemeroptera. There was no significant difference in the numbers of insects caught in suspended funnel traps and funnel traps standing on the bottom of the pond. Species of Ceratopogonids were consistently more numerous in the tent-trap than in the funnel-trap catches. The adult trapping devices were adequate for making qualitative but not quantitative estimations of populations of Ephemeroptera. When the adult and immature insect populations in a pond were sampled to the same degree, the emergence patterns of individual species and higher taxonomic groups could be predicted equally well from adult samples as from conventional samples of bottom deposit.

GAHAN (J. B.) & NOE (J. R.). **Control of Mosquito Larvae in Rice Fields with Water-soluble Phosphorus Insecticides.**—*J. econ. Ent.* **48** (1955) no. 6 pp. 665–667, 4 refs. Menasha, Wis., 1956.

Field tests of water-soluble insecticides for the control of mosquito larvae in rice-fields in Arkansas were carried out in July and August 1955. The insecticides were parathion, Shell OS 2064 (dimethyl 2-carbomethoxy-1-methylvinyl phosphate [also known as dimethyl 1-carbomethoxy-1-propen-2-yl phosphate]), Bayer L 13/59 [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate] and DDVP (dimethyl 2,2-dichlorovinyl phosphate). The parathion was in the form of a solubilised concentrate containing 1 part parathion and 4 parts Triton X-100, but the other insecticides were soluble enough to need no adjuvant. Solutions at concentrations adjusted to the field dosage required were released from an automatic device that delivered 52–55 ml. per minute into the irrigation water before it reached the fields.

In tests in small plots, parathion was completely effective against larvae of flood-water species of *Psorophora* at 0·01 part per million after flowing more than half a mile through a canal and 400 feet through a rice-field. A high degree of control also occurred in plots treated at 0·005 p.p.m., but some living larvae were found. Shell OS 2046 gave complete control and Bayer L 13/59 complete or almost complete control at 0·25 p.p.m. In one of these tests, the OS 2046 flowed for 528 yards through a canal and the same distance through the rice-field. DDVP gave high though not complete control at 0·05 and 0·1 p.p.m. It was not tested at higher concentrations. In large fields, *Psorophora* larvae were controlled after water treated with Bayer L 13/59 at 0·5 p.p.m. or parathion at 0·02 p.p.m. had travelled more than a mile in a canal and 2,500 feet through the rice. None of the treatments had enough lasting toxicity to be effective against *Anopheles quadrimaculatus* Say or *Culex erraticus* (D. & K.) one week after treatment. There was no apparent damage to the rice from any of the treatments.

GERSDORFF (W. A.), PIQUETT (P. G.) & NELSON (R. H.). **The relative Toxicity to House Flies of Pirazinon, Am. Cyanamid 4124, and Malathion in Comparison with Parathion and Pyrethrins.**—*J. econ. Ent.* **48** (1955) no. 6 pp. 680–681, 6 refs. Menasha, Wis., 1956.

It is estimated from tests against *Musca domestica* L. by the Campbell turntable method [*R.A.E.*, B **26** 246] that technical samples of malathion,

Pirazinon [O,O-diethyl O-2-propyl-4-methyl-6-pyrimidinyl thiophosphate] and Am. Cyanamid 4124 [O,O-dimethyl O-2-chloro-4-nitrophenyl thiophosphate] and pure parathion were, respectively, 2, 12, 20 and 33·4 times as toxic as pyrethrins (containing 61 per cent. pyrethrin I and cinerin I). At the concentrations used, the phosphorus compounds caused no knockdown or only negligible knockdown of flies in 25 minutes.

With respect to the relationship of chemical structure to toxicity, it is concluded that the substitution of isopropyl for n-propyl in Pirazinon, forming Diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl thiophosphate], increases toxicity by about 33 per cent. [*cf.* **42** 109], and the substitution of hydrogen (forming methyl parathion) for the chlorine atom in Am. Cyanamid 4124 increases toxicity by about 13 per cent. [*cf.* **39** 182].

Standifer (L. N.). **Larvicides for Control of the House Fly.**—*J. econ. Ent.* **48** (1955) no. 6 pp. 731–733, 5 refs. Menasha, Wis., 1956.

Results are given of an investigation of the toxicity to third-instar larvae of *Musca domestica* L. of 25 formulations of 15 insecticides that all gave complete mortality at a concentration of 250 parts per million in the breeding medium. Except for formulations of BHC and γ BHC (lindane), all chemicals investigated in the final series of tests had an LC50 of less than 8·7 p.p.m. These chemicals, with, in each case, type of formulation and LC50 in parts per million, were aldrin (23 per cent. emulsion) (0·9), EPN-300 [ethyl p-nitrophenyl thionobenzenephosphonate] (25 per cent. wettable powder) (0·92), Diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl thiophosphate] (25 per cent. emulsion) (0·98), dieldrin (18·5 per cent. emulsion) (1·18), parathion (1 per cent. wettable powder) (1·21), Bayer L 13/59 [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate] (technical water-soluble powder) (2·67), Bayer L 13/59 (10 per cent. water miscible) (3·39), Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl thiophosphate] (10 per cent. emulsion) (4·66), endrin (18·5 per cent. emulsion) (4·73), malathion (57 per cent. emulsion) (4·83), Bayer 21/199 (50 per cent. wettable powder) (8·38) and malathion (25 per cent. wettable powder) (8·65). Treated larvae pupated later than control ones, particularly those treated with the chlorinated hydrocarbons.

Terriere (L. C.) & Schonbrod (R. D.). **The Excretion of a Radioactive Metabolite by House Flies treated with Carbon^{14} labeled DDT.**—*J. econ. Ent.* **48** (1955) no. 6 pp. 736–739, 11 refs. Menasha, Wis., 1956.

House-flies [*Musca domestica* L.] of a DDT-resistant and a non-resistant strain were examined for evidence of metabolism of DDT up to 14 days after they had been treated with radioactive DDT labelled with ^{14}C. They were kept after treatment at 29°C. [84·2°F.]. Preliminary experiments indicated that all of the radioactivity applied could be accounted for in four fractions: a carbon-tetrachloride surface rinse, a n-hexane extract of the tissue, and carbon-tetrachloride and water extracts of the excrement. Most of the material in the excrement that was soluble in carbon tetrachloride was found to be DDE (1,1-bis(p-chlorophenyl)-2,2-dichloroethylene). Non-resistant flies that had received sublethal doses excreted up to 88 per cent. of the dose in the form of a water-soluble metabolite. Resistant flies similarly metabolised much of the dose and excreted the product. In both strains, a higher proportion of the dose was converted into water-soluble form and excreted if the original dose was small. The excretion begins during the first day after treatment and appears to continue over a period

of weeks until all the absorbed dose has been metabolised. The water-soluble material was hydrolysable with acid to produce a compound weakly acidic in nature. Attempts to identify this compound have failed although several possible structures have been eliminated.

GILBERT (I. H.), GOUCK (H. K.) & SMITH (C. N.). **New Mosquito Repellents.** —*J. econ. Ent.* **48** (1955) no. 6 pp. 741–743, 4 refs. Menasha, Wis,, 1956.

Of several recently synthesised repellents that had shown promise against *Aëdes aegypti* (L.) when applied to clothing, 11 that appeared non-irritant were tested on the skin. All were tested against *A. aegypti* and nine against *Anopheles quadrimaculatus* Say in the laboratory, and ten against salt-marsh mosquitos (*Aëdes taeniorhynchus* (Wied.) and *A. sollicitans* (Wlk.)) and eight against *Psorophora confinnis* (Lynch Arrib.) in the field. In all tests, 1 ml. repellent was spread evenly over the forearm and compared with a standard or another test repellent on the other arm. In the laboratory tests, each arm was exposed for three minutes at intervals of 20 or 30 minutes, and in the field the treated arms were exposed continuously. The standards used were dimethyl phthalate against *Anopheles*, 2-ethyl-1,3-hexanediol against *Psorophora*, a 6:2:2 mixture of dimethyl phthalate, 2-ethyl-1,3-hexanediol and Indalone against *Aëdes aegypti*, and either this mixture or a 4:3:3 mixture of the first two ingredients and dimethyl carbate against the salt-marsh species.

The following is based on the authors' summary of the results. The most consistently outstanding compound was N,N-diethyl-m-toluamide, which was equal or superior to the standard repellent against each species. Its ortho isomer was generally less effective but better than the standard. o-Ethoxy-N,N-diethylbenzamide was better than the standard against the species of *Aëdes* but not against the other mosquitos. Its o-bromo analogue was somewhat more effective against the former, but was not tested against the latter because it would be more costly to produce. A citral-malonic acid condensate was better than the standard against the salt-marsh mosquitos but equal or inferior to it against the other three species. Propyl mandelate was more effective than the standard against the species of *Aëdes* but less effective against the other two mosquitos.

MITLIN (N.) & BABERS (F. H.). **Relative Toxicity of topically applied Allethrin and Pyrethrins to House Flies and Cockroaches.**—*J. econ. Ent.* **48** (1955) no. 6 pp. 747–748, 9 refs. Menasha, Wis., 1956.

The relative toxicities of allethrin of 94 per cent. purity and pyrethrins (60·5 per cent. pyrethrin I and cinerin I) to females of *Musca domestica* L. of strains resistant and non-resistant to DDT, adult males of *Blattella germanica* (L.) of insecticide-resistant and non-resistant strains [*R.A.E.*, B **41** 179] and last-instar nymphs of *Periplaneta americana* (L.) were evaluated by topical application of various dosages. Regression lines were fitted graphically to the data. The lines for the two insecticides were parallel for the non-resistant strains of *Musca* and *Blattella* but the lines for the resistant strains tended to converge [*cf.* **39** 24]. Allethrin was found to be about equal to pyrethrins in toxicity to both strains of *Musca* at the LD50 level [*cf.* **38** 208], 0·03 times as toxic to both strains of *Blattella* [*cf.* **38** 208; **39** 24] and 0·15 times as toxic to *Periplaneta*.

Laake (E. W.). **Experimental Compounds for Control of Chlordane-resistant German Cockroaches.**—*J. econ. Ent.* **48** (1955) no. 6 p. 753. Menasha, Wis., 1956.

In field tests in Texas on the control of chlordane-resistant cockroaches (*Blattella germanica* (L.)), emulsion sprays containing 1 or 1·5 per cent. Chlorthion [O,O-dimethyl O-3-chloro-4-nitrophenyl thiophosphate], or mixtures of 1 per cent. Chlorthion with 1 per cent. dieldrin, 2 per cent. malathion with 1 per cent. dieldrin, 1·2 (or 1·8) per cent. malathion with 2·4 (or 3·6) per cent. Perthane [1,1-bis(p-ethylphenyl)-2,2-dichloroethane (ethyl DDD)], or 1·6 per cent. malathion with 1·6 per cent. Strobane [a chlorinated mixture of α-pinene isomers] were applied with a pressure sprayer to grocery stores, meat markets, food factories and dwellings. Treatments were not complete enough to eradicate infestations with one application. Chlorthion was highly effective against *Blattella* where resistance to chlordane was high, but it was completely ineffective against the American cockroach [*Periplaneta americana* (L.)]. The mixture of Chlorthion and dieldrin was effective against both these cockroaches and eliminated bed bugs [*Cimex lectularius* L.] with one treatment. However, Chlorthion, whether alone or in the mixture, was objectionable to the operators and those who worked in the treated buildings. The mixture of malathion and dieldrin was effective against the resistant *Blattella* and against *Periplaneta* and Oriental cockroaches [*Blatta orientalis* L.] in a factory and against *Blattella* and *Periplaneta* in a dwelling. This mixture had no objectionable smell, but the concentration of dieldrin might be considered dangerously high if the mixture was used freely in homes or food stores. The mixtures of malathion with Perthane or Strobane were effective against the chlordane-resistant *Blattella* and against *Periplaneta*, and they had no objectionable smell, were pleasant to handle and were not irritating or offensive in any way.

Ryckman (R. E.). **Potentialities of the Otoscope in entomological Research.**—*J. econ. Ent.* **48** (1955) no. 6 pp. 755–756, 1 fig. Menasha, Wis., 1956.

The author has found the otoscope useful in various aspects of the study of arthropods in confined spaces. It provides a portable means of producing a small intense beam of light in small recesses and cavities, with the added advantage of a built-in magnifying lens. It has become a standard item of equipment for inspecting the ears of mammals for small ectoparasites in the field.

Roth (A. R.) & Johnson (J. B.). **Tests with Dieldrin as a Systemic against Cattle Grubs.**—*J. econ. Ent.* **48** (1955) no. 6 pp. 761–762, 1 ref. Menasha, Wis., 1956.

In preliminary studies made in Oregon in 1953 on the effectiveness of dieldrin as a systemic insecticide against *Hypoderma lineatum* (Vill.) and *H. bovis* (Deg.) [*cf. R.A.E.*, B **43** 187], four yearling cattle received two subcutaneous injections of a 5 per cent. suspension of dieldrin in groundnut oil at 25 mg. per kg. body weight, one on 23rd January when only *H. lineatum* was present in their backs and one on 20th March when only *H. bovis* was present. Two similar animals were used as controls. Larvae that reached maturity were collected in small perforated plastic boxes glued over the cysts and kept in vials containing moistened sand for pupation. The four treated animals had 43 second-instar and 58 third-instar larvae

when the first injection was made. Of these, 78 died as larvae and the others failed to give rise to adults. The control animals had four second-instar and 12 third-instar larvae, of which 11 died as larvae and four gave rise to adults. None of the 24 larvae that encysted on the treated animals or of the 17 that encysted on the controls after the date of treatment gave rise to adults. Of the 16 larvae present on animals receiving their second treatment, eight died and eight pupated normally but no adults emerged. Eight new larvae encysted after treatment, but six of them died and no adults emerged. Seven of the 11 larvae on the control cattle at the time of the second treatment and two of the five that encysted later developed to the adult stage.

Howell (D. E.) & Schomberg (O.). **Oklahoma Tabanidae.**—*J. econ. Ent.* **48** (1955) no. 6 pp. 763–764, 1 ref. Menasha, Wis., 1956.

Tabanids are among the most serious pests of livestock in Oklahoma. A list is given of the 70 species and subspecies that have been collected in the State, showing the dates in the year between which nearly all were found and indicating new State records.

Cole (M. M.). **Resistance to Ovicides by Eggs of the Body Louse.**—*J. econ. Ent.* **48** (1955) no. 6 pp. 764–765, 10 refs. Menasha, Wis., 1956.

The possible development of resistance to insecticides in eggs of *Pediculus humanus humanus* L. was examined in Florida early in 1955. The eggs used were of the extremely DDT-resistant Korean strain of the louse, maintained since 1951 on cloth impregnated with a 0·01 per cent. solution of DDT [*R.A.E.*, B **44** 18], and a normal laboratory strain reared since 1942 without exposure to insecticide. Cloth pads bearing 50–100 eggs were dipped in acetone solutions of the test compounds and then kept at 82° F. and 60–70 per cent. relative humidity until hatching was complete in an untreated batch. Eggs of the Korean strain showed no resistance to γ BHC (lindane) or dinitroanisole, but were very resistant to Lauseto neu [chloromethyl p-chlorophenyl sulphone]. With all concentrations of Lauseto neu tested (0·01–10 per cent.), mortality among eggs of the Korean strain was 11–22 per cent., which was about the same as mortality in the untreated controls of both strains and among eggs of the normal strain treated with 0·01 per cent., but mortality among eggs of the normal strain treated with 0·25 per cent. or more was 55–66 per cent. [*cf.* **37** 167]. The concentrations of Lauseto neu and γ BHC needed to give complete mortality of adults of the F_{50} generation of the Korean strain were, respectively, 400 times and twice those needed for complete mortality of adults of the normal strain.

Cole (M. M.) & Lloyd (G. W.). **Tests with Repellents against the American Dog Tick.**—*J. econ. Ent.* **48** (1955) no. 6 pp. 772–773, 2 refs. Menasha, Wis., 1956.

Field tests with dibutyl adipate and nine repellent mixtures as clothing treatments against *Dermacentor variabilis* (Say) were carried out during June and July 1952 on Long Island, New York [*cf. R.A.E.*, B **38** 185; **40** 62]. All the mixtures contained 10 per cent. Tween 80 as an emulsifier and (with the exception of M-2059) 30 per cent. of each of the other ingredients, and they and dibutyl adipate were used as emulsions to impregnate trousers of herringbone twill, dibutyl adipate at 2 gm. and the mixtures at 3·6 gm. per sq. ft. Men wearing trousers treated 7–9, 13–14, 15–17 and in the case

of some treatments 20–22 or 27–28 days earlier, and one wearing untreated trousers, walked slowly in the vegetation on roadsides heavily infested with adult ticks, which were allowed to crawl on to their trousers. Ticks that reached the bottom of the pockets were removed and counted. On the basis of performance in the first three tests, the best treatments (with their percentage repellency in brackets) were M-1960, which contained 2-butyl-2-ethyl-1,3-propanediol, benzyl benzoate and N-butylacetanilide (93), M-2059, which contained 99 per cent. M-1960 and 1 per cent. γ BHC as lindane (89), M-2061, which contained 2-butyl-2-ethyl-1,3-propanediol, dibutyl adipate and N-butylacetanilide (86), and dibutyl adipate alone (86). These four treatments gave, respectively, 90, 93, 96 and 63 per cent. protection after 27–28 days.

Trapido (H.), Galindo (P.) & Carpenter (S. J.). **A Survey of Forest Mosquitoes in Relation to sylvan Yellow Fever in the Panama Isthmian Area.**—*Amer. J. trop. Med. Hyg.* **4** no. 3 pp. 525–542, 2 figs., 11 refs. Baltimore, Md., 1955.

The failure of surveys of the human population in Panama west of the Canal Zone to reveal immunity from yellow fever in people born since 1925, whereas young people showed immunity in the east, suggested that jungle yellow fever had been present unrecognised in the east but was not endemic in Central America to the west and north of the Canal Zone. It was therefore resolved to survey the mosquito fauna of the forest canopy with a view to establishing the elements that determined the suitability of the forests of eastern Panama and the presumed unsuitability of those of the west for the propagation of jungle yellow fever. An outbreak occurred just to the east of the Canal late in 1948, and the first mosquito surveys showed *Haemagogus spegazzinii falco* Kumm, Osorno & Boshell and *Aëdes leucocelaenus* Dyar & Shann., two recognised vectors of the disease in South America, to be present in some abundance there [*R.A.E.*, B **39** 212; **41** 25–26]. *A. leucocelaenus* was represented by its subspecies *clarki* Galindo, Carpenter & Trapido [**42** 115].

In 1950, mosquitos were collected at ground level and in the canopy at 17 stations in Panama on both sides of the Canal Zone and one in the south-east of Costa Rica from 9 a.m. to 3 p.m. at different intervals for various periods during the rainy season. Over 72,000 mosquitos of 72 species were caught during 8,015 hours' collection, 31,530 in the canopy and 40,681 on the ground. The number caught at each station is shown for each species, and the percentages at ground and canopy levels for those of which more than 15 individuals were taken. Most of the species could be characterised as biting either on the ground or in the canopy. *H. equinus* Theo. and *H. s. falco* comprised 6,488 and 750 of the 11,848 individuals of *Haemagogus*. The latter was the least abundant of the widely distributed members of the genus, but it extended to Costa Rica. The members of the subgenus *Finlaya* of *Aëdes* were *A. leucotaeniatus* Komp, *A. terrens* (Wlk.) and *A. leucocelaenus clarki*. All were present in Costa Rica and widely distributed in Panama. Over 60 per cent. of *A. l. clarki* and over 80 per cent. of *H. s. falco* were taken in the canopy. Both were abundant only at the one station that was north of the continental divide on the Atlantic slope, where the rainfall is high with no clearly marked dry season and there is well developed tropical rain forest. It seems unlikely that these two species could maintain yellow fever on the Pacific slope, which has lower and more scrubby forest (deciduous tropical forest) mixed with savannah, and which is where most of the rural population lives. If they are the only vectors, it is possible that the disease could pass through western Panama only on the Atlantic side. Cases began to occur in western Panama in 1950,

and others subsequently appeared in Costa Rica, Nicaragua and Honduras, and their distribution in Panama and Costa Rica supported the theory.

The composition of the mosquito fauna offered no explanation of the failure of jungle yellow fever to appear west of the Canal Zone before 1950. Besides the two known vectors, the other species of *Haemagogus* and *Finlaya* found and species of *Sabethes*, which might also be considered possible vectors on epidemiological grounds, are distributed continuously through the Isthmian region, except *H. regalis* D. & K. (*lucifer* (H., D. & K.)), which is replaced in western Panama and Costa Rica by *H. iridicolor* Dyar. It is suggested that the gap in the mountain system in the area of the Canal Zone results in the passage of moisture that would otherwise fall on the Atlantic side to the Pacific slope in amounts inadequate to produce true rain forest there but depriving the Atlantic side of the moisture necessary to maintain it. Conditions for *H. s. falco* and *A. l. clarki* are consequently marginal in the area, and the ability of the virus to cross this marginal zone and reach the northern part of western Panama would depend on its approaching from the east in a year when particularly favourable rainfall conditions resulted in a maximum production of the vector species at the critical time. This theory would be supported by the demonstration of long-term as well as annual cycles of abundance in the mosquitos. Continued observations, the results of which are to be reported in a separate paper, provided such support.

Galindo (P.) & Trapido (H.). **Forest Canopy Mosquitoes associated with the Appearance of sylvan Yellow Fever in Costa Rica, 1951.**—*Amer. J. trop. Med. Hyg.* **4** no. 3 pp. 543–549, 3 figs., 6 refs. Baltimore, Md., 1955.

Jungle yellow fever appeared in the Atlantic drainage area of Costa Rica in 1951, producing a widespread epizootic in monkeys and a number of human cases with some deaths. Collections of forest-canopy mosquitos were made during August and September at two localities (Wauchope and San Gerardo) in which the disease was active, and the catches are shown in a table. *Haemagogus spegazzinii falco* Kumm, Osorno & Boshell was the commonest mosquito at Wauchope and was at least as abundant at San Gerardo as it had been at localities in which yellow fever appeared in Panama in 1949–50 [*cf.* preceding abstract]. It is considered the probable vector in the outbreak. Though it ordinarily inhabits the canopy of primary tropical rain forest, it was found commonly at Wauchope at ground level in cacao plantations in which enough of the original forest cover had been left to provide partial shade. Apparently, in these circumstances, the conditions of light, temperature and humidity that comprise the microclimate of the canopy are simulated at ground level, the stratification of such mosquitos as *H. s. falco* is less pronounced, and jungle yellow fever could be transmitted at ground level. Other species of *Haemagogus* were present, but their vector status is not known. The numbers of *H. s. falco* were ample to explain the transmission of yellow fever. The commonest species of *Sabethes* was *S. chloropterus* (Humb.), which was suspected of being a vector on epidemiological grounds in Panama. *Aëdes leucocelaenus clarki* Galindo, Carpenter & Trapido was too rare to warrant consideration.

Wallis (R. C.). **A Study of the Oviposition Activity of three Species of *Anopheles* in the Laboratory.**—*Amer. J. trop. Med. Hyg.* **4** no. 3 pp. 557–563, 13 refs. Baltimore, Md., 1955.

Tests were carried out with *Anopheles quadrimaculatus* Say, *A. freeborni* Aitken and *A. aztecus* Hffm. to determine whether oviposition while the

mosquitos were in flight might be responsible for the unnatural distribution of eggs often observed in experiments on the choice of oviposition sites [*cf. R.A.E.*, B **31** 218, etc.]. In an experiment with seven dishes, 5 cm. apart, of water containing 0–6 per cent. sodium chloride, some of the mosquitos were seen to be ovipositing while in contact with the surface of the fresh water, but others oviposited while in flight and scattered their eggs over the dishes to an extent that gave the impression of random distribution. When the mosquitos were kept in flight over a dish of water surrounded by dry dishes, the average numbers of eggs of *quadrimaculatus*, *freeborni* and *aztecus* per dry dish, expressed as percentages of the numbers in the dish of water, were 35·6, 5·5 and 5·2 when the distance between the dishes was 5 cm., and 2·3, 2·5 and 6·3 when it was increased to 10 cm. The difference between species in the effect of increasing the distance between dishes is explained by differences between their flight patterns, the range of flight being widest for *aztecus*. An experiment designed to give an estimate of the percentages of eggs that are laid in flight is also described, and it is calculated from it that these percentages are 88 for *quadrimaculatus*, 8·8 for *freeborni* and 1·1 for *aztecus*.

Atiq-ur-Rahman Ansari (M.) & Swaleh Nasir (A.). **A preliminary Note on Anophelism of Lahore Suburbs.**—*Pakist. J. Hlth* **4** no. 4 pp. 212–223, 4 graphs, 12 refs. Lahore, 1955.

Anophelines were collected weekly between 10 and 11 a.m. in a dwelling and a cattle shed in each of six villages on the outskirts of Lahore between July 1953 and December 1954. Notes are given on the abundance and seasonal incidence of the species taken. These, in order of decreasing prevalence, were *Anopheles subpictus* Grassi, which formed 87·3–98·7 per cent. of the total catch in July–September when rainfall was heavy, *A. annularis* Wulp, which formed 83–94 per cent. of the total in January–March when there was a secondary period of rain, *A. stephensi* List., *A. pulcherrimus* Theo., *A. culicifacies* Giles, *A. hyrcanus* (Pall.) and *A. fluviatilis* James. The last was represented by only one adult in 1953–54, but another was taken in 1955. The authors had found a few individuals of *A. splendidus* Koidz. in 1950; it had not previously been recorded from Lahore, and its presence in the local fauna is accepted with reserve. The vectors of malaria are believed to be *A. culicifacies* and *A. stephensi*, which were most prevalent in October–January and March–May, respectively, when they formed 15 and 30 per cent. of the catch.

Chamberlain (R. W.), Kissling (R. E.), Stamm (D. D.), Nelson (D. B.) & Sikes (R. K.). **Venezuelan Equine Encephalomyelitis in Wild Birds.** —*Amer. J. Hyg.* **63** no. 3 pp. 261–273, 9 refs. Baltimore, Md., 1956.

Wild birds of five species trapped in Alabama and pigeons (*Columba livia*) were infected with the virus of Venezuelan equine encephalomyelitis (VEE) by subcutaneous inoculation or by the bite of infected females of *Aëdes triseriatus* (Say) but usually showed no symptoms. Their blood-virus titres at various periods during infection and the amounts of neutralising antibody subsequently developed are shown in tables. Females of *A. triseriatus* were infected by feeding on infected birds, and occasionally transmitted the virus from one bird to another. The blood-virus titres are expressed as mouse intraperitoneal LD50's per 0·025 ml. blood, and the threshold for infection of *A. triseriatus* [*cf. R.A.E.*, B **44** 38] appeared to be a titre of about $10^{2 \cdot 5}$.

The virus was shown to multiply up to 10,000 times or more in the mosquito, but mosquito eggs laid after an infective feeding contained no virus that could be detected by mouse inoculation. The possible part played by birds in the cycle of the disease in nature is discussed. It is believed that VEE is mainly a mammal-mosquito disease, as the amounts of virus circulating in the blood of infected mammals are greater than those observed in the birds. However, as birds may become infected and serve as a source of infection for mosquitos, they may play a part in maintaining endemic infection, particularly in view of their high replacement rate.

Kissling (R. E.), Chamberlain (R. W.), Nelson (D. B.) & Stamm (D. D.). **Venezuelan Equine Encephalomyelitis in Horses.**—*Amer. J. Hyg.* **63** no. 3 pp. 274–287, 4 graphs, 12 refs. Baltimore, Md., 1956.

Five horses that received 32, 4,270 or 42,700 mouse intraperitoneal LD50's of the virus of Venezuelan equine encephalomyelitis (VEE) by subcutaneous injection became infected, with virus circulating in the blood, and one of the two that had received the lowest dose and the one that had received the highest died. Intranasal installation of 94,000 or 188,000 LD50's of the virus also caused infection, which, in the case of the higher dosage, was fatal, but installation of 250 LD50's or less did not cause infection. Virus was shed in the nasal, eye, and mouth secretions, urine and milk of an infected horse, and infection was transmitted from one horse to another by direct contact. In experiments with mosquitos, females of *Aëdes triseriatus* (Say) transmitted the virus from a guineapig to a horse and from one horse to another, females of *Mansonia indubitans* Dyar & Shann. and *M. titillans* (Wlk.) acquired infection by feeding on an infected horse, and a female of *M. indubitans* transmitted the virus from one guineapig to another. Attempts to isolate virus from the eggs of infected females of *A. triseriatus* were negative.

The infection in horses did not always involve the central nervous system, even when fatal. The type of disease produced was not related to the route of infection. Haematological and pathological findings are noted, and data are given on the distribution of virus in the tissues. One of the more important ways in which VEE differs from the other American equine encephalitides is that it develops high virus titres in the blood of the horse and so can be transmitted from horse to horse by mosquito [*cf. R.A.E.*, B **44** 39].

Baltazard (M.), Bahmanyar (M.) & Chamsa (M.). **Sur la fièvre récurrente en Afghanistan.**—*Bull. Soc. Path. exot.* **48** no. 2 pp. 159–161, 5 refs. Paris, 1955.

Cases of relapsing fever that have occurred sporadically in Afghanistan have always been presumed to be tick-borne, though there was hitherto no proof. A new-born rabbit on which three ticks (*Ornithodoros tholozani* var. *pavlovskyi* Desportes & Campana) of a batch of 13 found in a stable in a village near Kabul were allowed to engorge showed spirochaetes in its blood six days later. It was subsequently found that only one of the three ticks was infected. Passage experiments showed that the spirochaete caused an inapparent infection in adult rabbits, intense and prolonged infection with no deaths in new-born and adult guineapigs, mild but prolonged infection in rats and white mice, and prolonged infection in man. It is concluded that it was *Borrelia persica*.

Montestruc (E.). **La régression du paludisme à la Martinique.**—*Bull. Soc. Path. exot.* **48** no. 2 pp. 234–242, 1 graph, 8 refs. Paris, 1955.

A campaign for the suppression of malaria in Martinique by the distribution of prophylactic drugs was begun in 1935, interrupted in 1946 and resumed in 1947. Little direct Anopheline control was carried out during the period, but the construction of an aerodrome during 1947–51 on former marsh-land eliminated large numbers of breeding places, and a DDT campaign was begun in 1951. *Plasmodium vivax*, originally the preponderant parasite, had practically disappeared by 1945 and *P. falciparum*, which became very plentiful in 1941–44 and 1946–47 in epidemic outbreaks outside the main endemo-epidemic zone, became scarce in 1949. No malaria parasites at all were found in 1953 or 1954. The number of clinical cases has also fallen steadily. The cause of the regression was almost certainly the chemoprophylaxis, but the decrease in the population of *Anopheles* that followed it is considered of importance in stabilising the position.

Merle (F.) & Maillot (L.). **Campagnes de désinsectisation contre le paludisme à Brazzaville.**—*Bull. Soc. Path. exot.* **48** no. 2 pp. 242–269, 3 graphs, 12 refs. Paris, 1955.

Malaria was hyperendemic in Brazzaville in 1950 and had become hypoendemic [*R.A.E.*, B **44** 191] by 1955. This result was achieved by a combination of Anopheline control and chemoprophylaxis among the human population. There are five species of *Anopheles* in the area, but the only malaria vectors are *A. gambiae* Giles and *A. moucheti* Evans. The latter is present from December to March and in one part of the town only and plays an insignificant part in transmission. In addition to chemoprophylaxis, the measures discussed that were thought to have value were control of *A. gambiae* out of doors by DDT applied three times at intervals of ten days just after the end of the rains from aeroplanes, helicopters or equipment mounted on vehicles; treatment of dwellings with DDT or BHC, if possible at intervals of six months for the former and three months for the latter; location of breeding places and their treatment with larvicides or by mechanical measures suited to local conditions, and the use of larvivorous fish. Data are given on personnel, equipment and methods. The results of various surveys are summarised, and it is shown that Anopheline densities fell by about 60 per cent. between 1948–50 and 1954–55, sporozoite rates in *A. gambiae* and the number of infected females per 100 houses were reduced, and the parasite rate in children fell by about 90 per cent. There did not appear to be any great reduction in numbers of larvae of *A. gambiae*. These results are attributed mainly to the effects of the DDT campaign. The author advocates the suspension of the use of drugs in the dry season (June–September) for one year and for a longer period in the next year with the aim of stopping chemoprophylaxis completely in 2–3 years if the results of mosquito control are satisfactory.

Elliott (R.) & Ramakrishna (V.). **Insecticide Resistance in *Anopheles gambiae* Giles.**—*Nature* **177** no. 4507 pp. 532–533, 4 refs. London, 1956.

Busvine (J. R.). **Normal Resistance-levels of *Anopheles gambiae* to various Insecticides.**—*T. c.* pp. 533–534, 3 refs.

In the experiments that are the subject of the first paper, the susceptibility to dieldrin of females of *Anopheles gambiae* Giles from two towns in

Northern Nigeria in which all houses had been treated three times at intervals of six months, beginning in June 1954, with a spray prepared from 50 per cent. dieldrin wettable powder was compared with that of females from an unsprayed area. The dieldrin was applied at 25 mg. per sq. ft. in one of the towns (Gwandu) and at the same rate for the first two treatments and at 50 mg. for the third at the other (Birnin Kebbi). The susceptibility of the Birnin Kebbi mosquitos to DDT was also tested. Fed mosquitos were exposed for one hour to filter papers impregnated with a 1:2 mixture of an oil solution of the toxicant and trichloroethylene, and mortality was observed after 24 hours. Mortality among controls exposed to the oil and trichloroethylene without toxicant was low. Concentrations of 0·5, 1, 2 and 4 per cent. dieldrin gave 5, 16, 45 and 83 per cent. mortality of females bred from larvae from Birnin Kebbi, and 20, 33, 60 and 93 per cent. mortality of females caught at Gwandu. The same concentrations of DDT gave 0, 5, 92 and 100 per cent. mortality of females reared from Birnin Kebbi larvae. Dieldrin at all these concentrations gave 100 per cent. kill of females from the unsprayed area. The median lethal concentrations (MLC's) of dieldrin and DDT for the Birnin Kebbi females were estimated to be 2 and 1·6 per cent. These results in conjunction with those recorded in the second paper probably indicate that the mosquitos can survive the dieldrin treatments now used.

The results of preliminary investigations on the normal susceptibility of *A. gambiae* to DDT, γ BHC and dieldrin are given in the second paper. Such data are valuable as bases of comparison if the possible development of resistance has subsequently to be investigated. The strains of *A. gambiae* used were from Lagos (Nigeria) and Tengeni (Tanganyika) and had been reared in captivity for about 20 and five generations, respectively. Only the Lagos strain was used in tests with dieldrin. Both were used in tests with DDT and BHC, but as they showed no material differences, the results were combined. Females were exposed to treated filter papers by a method already noticed [*R.A.E.*, B **41** 156], and the percentages killed (corrected for the overall control mortality, which was 8 per cent.) were 91, 53, 34 and 13 by 2, 1, 0·75 and 0·5 per cent. DDT, 100, 96, 74 and 24 by 0·06, 0·03, 0·02 and 0·01 per cent. γ BHC, and 100, 95, 59 and 29 by 0·45, 0·4, 0·3 and 0·2 per cent. dieldrin. It was estimated from these data that the MLC's were 0·95 per cent. for DDT, 0·015 per cent. for γ BHC and 0·25 per cent. for dieldrin.

J. G. Halcrow, working with *A. gambiae* from unsprayed areas in Mauritius in 1954, obtained percentage kills of 100, 75 and 41 with 2, 1 and 0·5 per cent. DDT, and 100, 64 and 28 with 0·5, 0·3 and 0·2 per cent. dieldrin. These figures indicate MLC's of 0·7 per cent. for DDT and 0·25 per cent. for dieldrin.

Toxic Hazards of Pesticides to Man. Report of a Study Group.—*Tech. Rep. World Hlth Org.* no. 114, 51 pp., refs. Geneva, 1956.

This is the report of a study group that met under the auspices of the World Health Organisation in June 1956. The main subjects considered in it are the toxic properties of pesticides (notably insecticides, fungicides and herbicides), the incidence and nature of human poisoning, measures for the protection of operators handling pesticides, the contamination of food and water, effects on domestic animals and fish, and the control of pesticide hazards by means of regulations. Three annexes contain information on laboratories carrying out investigations on the vertebrate toxicology of pesticides, the degree of exposure of workers to insecticides and the relation

of this exposure to the toxic dosage, and respirators and dust masks suitable for pesticide operators.

Insecticides and Repellents for the Control of Insects of medical Importance to the Armed Forces.—*Circ. U.S. Dep. Agric.* no. 977, [2+] 91 pp., 31 figs., 15 refs. Washington, D. C., 1955.

This circular, which supersedes a publication already noticed [*R.A.E.*, B **37** 53], comprises a summary of information on materials and methods that, mainly as a result of research in the United States since 1942, have proved to be or shown promise of being of practical value to the armed forces for controlling arthropods of medical importance or giving protection against them. Most of the methods developed are applicable with modifications to civilian use. The properties and methods of analysis of DDT, BHC, chlordane, heptachlor, dieldrin and aldrin are given, together with notes on the nature of pyrethrum and allethrin, and brief references to some other insecticides. Various insecticide formulations (solutions, emulsifiable concentrates, wettable powders, dusts and dusting powders, granulated insecticides and liquefied-gas aerosols) are discussed, and the specific gravity and melting and boiling points of certain repellents are given. The specification, specification number, Federal stock number, if any, and active ingredients of the insecticidal and repellent preparations issued to the United States forces and the specification and numbers of articles of equipment are shown in tables.

Measures against mosquitos and, more briefly, other pests are then reviewed. Those directed against mosquitos include the use of DDT dusts and of DDT and other compounds as sprays against the larvae; application of larvicides in capsules or pellets, on granular bentonite or sawdust or from drip cans; prehatching treatments; the control of adults out of doors by insecticide deposits on low vegetation or litter, or by DDT applied as a space spray with hand-operated or powder equipment, as a liquefied-gas aerosol, or from mist blowers or thermal fog generators; and control indoors by aerosols, space sprays or deposits, mainly of DDT. Mosquito control by insecticides applied from aircraft is also discussed at some length. Methods of controlling *Musca domestica* L. are the use of insecticide deposits, space sprays and aerosols containing DDT and allethrin, pyrethrum or aliphatic thiocyanates, poisoned baits and larvicides (paradichlorobenzene, sodium arsenite, DDT, dieldrin or BHC). The use of louse powders containing DDT, γ BHC or pyrethrins (the MYL-type powder [*cf.* **37** 54]) and impregnation of garments with DDT are methods discussed for the control of *Pediculus humanus humanus* L., and the use of a 20 per cent. emulsion of NBIN applied as a spray or with a sponge to the hairy parts of the body against *P. h. humanus*, *P. h. capitis* Deg. and *Phthirus pubis* (L.) and to the whole body against *Sarcoptes scabiei* (Deg.). NBIN is an emulsion concentrate containing 68 parts by weight benzyl benzoate, 6 parts DDT, 12 parts benzocaine [ethyl p-aminobenzoate] and 14 parts Tween 80. Other arthropods, the control of which is briefly dealt with, are *Phlebotomus* spp., Simuliids, bed bugs (*Cimex lectularius* L. and *C. hemipterus* (F.)) and fleas, for which DDT is recommended, cockroaches and ants, to which chlordane is particularly toxic, and *Culicoides* spp., ticks and Trombiculid larvae, against which various organic compounds have been shown to be valuable.

There are also sections on the application of repellents to the skin and to clothing, the protection of pack animals from attack by arthropods, and

the toxicology of insecticides and repellents and precautions to be taken when using them.

DuBois (K. P.) & Cotter (G. J.). **Studies on the Toxicity and Mechanism of Action of Dipterex.**—*A. M. A. Arch. industr. Hlth* **11** pp. 53–60, 4 graphs, 10 refs. Chicago, Ill., 1955.

Dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate (also known as dipterex or Bayer L 13/59) has recently been found to be highly effective for the control of house-flies [*Musca domestica* L.] [*cf. R.A.E.*, B **42** 109; **43** 26, 102, 118; **44** 170], and the experiments described in this paper show that its toxicity to mammals is relatively low. Its LD50's in mg. per kg. body weight were 225 for rats, 450 for guineapigs and 500 for mice when it was administered intraperitoneally and 450 for rats when it was given orally. Its action was rapid, and death or recovery occurred within a few hours. Cumulative action was tested over a period of 60 days by intraperitoneal injection of daily doses of 50, 100 and 150 mg. per kg. to rats. All of five rats receiving 50 mg. survived, as did three of five receiving 100 mg., but all of five receiving 150 mg. died during the treatment.

The symptoms produced in the rats that died suggested that the compound inhibited cholinesterase, though it differed from other alkyl phosphates that do this in its low toxicity to mammals and the short duration of its action. Experiment showed that it inhibited brain and serum cholinesterases *in vitro* and that its action was not reversible and was similar to that of the most toxic phosphorus insecticides, whereas intraperitoneal administration of 125 mg. per kg. to rats produced a marked decrease in the cholinesterase activity of all the tissues to levels that were 10–15 per cent. of normal 15 minutes after poisoning, but the inhibitory effect was short. Rapid dissociation of the enzyme-inhibitor combination *in vivo* may be one of the factors responsible for the relatively low toxicity of the insecticide. When repeated daily doses large enough to cause death were given, a progressively greater inhibition of cholinesterase occurred after each successive dose until the enzyme activity reached low levels and death occurred. This cumulative action appears to be due to irreversible inactivation of part of the enzyme after each successive dose rather than to accumulation of the chemical agent in the tissues.

Since no sufficiently sensitive chemical method for measurement of the compound is available, the authors employed its action on rat brain cholinesterase as a bioassay method. A test with contaminated milk showed that the method would be applicable for analysis of food samples, and it was also used for assay of blood, liver and urine from poisoned animals. It was thus shown that the compound rapidly disappears from the tissues, but it is not excreted in the urine to any appreciable extent in the unchanged form. It is concluded that its rapid detoxification largely accounts for its low toxicity and the short duration of its action in mammals.

Curtis (L. C.). **A Case of Aural Myiasis in Man.**—*Canad. J. publ. Hlth* 1956 pp. 298–299, 3 refs. Toronto, 1956.

One of two Dipterous larvae that had been removed from the ear of a boy in Alberta early in October 1954 and had pupated soon afterwards gave rise in March 1955 to an adult that was identified as *Sarcophaga citellivora* Shewell. This species was described in 1950 from specimens collected in British Columbia from lesions on a Columbian ground squirrel (*Citellus columbianus*).

Burgdorfer (W.) & Owen (C. R.). **Experimental Studies on Argasid Ticks as possible Vectors of Tularemia.**—*J. infect. Dis.* **98** pp. 67–74, 11 figs., 11 refs. Chicago, Ill., 1956.

Nymphs of *Ornithodoros moubata* (Murr.), *O. turicata* (Dugès), *O. parkeri* Cooley and *O. hermsi* Wheeler were infected with *Bacterium* (*Pasteurella*) *tularense* by feeding on infected mice, and the course of infection in the ticks was followed over a period of 450 days, during which they were kept at a relative humidity of 78–80 per cent. The ingested organisms developed in the tissues of the intestinal tracts, salivary glands, coxal organs, central ganglion and excretory and genital systems and persisted throughout the observation period in all species. The coxal fluids of *O. moubata, O. turicata* and *O. parkeri*, as well as anal excretions of all four species contained large masses of *B. tularense*. The coxal fluids of *O. hermsi* dry as soon as they reach the external openings of the coxal organs. In 472 transmission experiments in which the ticks were fed on mice individually or in lots of 2–5 at different intervals up to more than 200 days after the ingestion of infective blood, all species transmitted the infection. The most efficient vector was *O. moubata*, which infected 76 of the 287 mice on which it fed. *O. parkeri, O. turicata* and *O. hermsi* infected eight of 34, 15 of 156 and five of 96, respectively. The fact that *O. hermsi* was the poorest transmitter suggests that contamination of the feeding wounds by coxal fluid is more important than direct transmission by biting. Wounds are unlikely to have been contaminated by anal excretions, as these are usually not voided until the tick has left the host. The results given indicate that Argasids may be of importance in the maintenance and distribution of *B. tularense* among their hosts in nature [*cf. R.A.E.*, B **27** 148; **28** 98, 197; **32** 138].

Hornstein (I.), McGregor (W. S.) & Sullivan (W. N.). **Lowering the Volatility of Lindane Cattle Sprays by Addition of Film-forming Material.**—*J. agric. Fd Chem.* **4** no. 2 pp. 148–149, 1 graph, 8 refs. Easton, Pa., 1956.

Toxic effects in cattle have been reported when sprays containing more than 0·1 per cent. γ BHC (lindane) were used on them, treatment of dairy cows results in contamination of the milk, and the volatility of the insecticide necessitates frequent retreatment. As its volatility can be lowered by incorporating it in a film-forming mixture of isomeric chlorinated terphenyls (Aroclor 5460) [*R.A.E.*, B **42** 131, etc.], laboratory tests were made in Texas in which a pressurised spray of equal parts of γ BHC and Aroclor in a volatile solvent was compared with conventional applications of γ BHC in emulsified solution. It was hoped that the deposit from the mixture would adhere to the tips of the hairs and have little tendency to volatilise or be absorbed by the animal. One yearling received about 20 gm. γ BHC in a spray containing 454 gm. each of γ BHC and Aroclor in 1 litre methyl ethyl ketone applied at a pressure of 100 lb. per sq. inch and another received about 2 gm. γ BHC in a 0·05 per cent. emulsion. The animals were kept separately in an insectary, and 100 stable flies [*Stomoxys calcitrans* (L.)] and 100 horn-flies [*Siphona irritans* (L.)] were released on them periodically. All flies on both animals were knocked down in 20 minutes one day after treatment, but the emulsion was ineffective by the next day, whereas the mixture gave complete knockdown in 32 minutes after 18 days and in 24 and 48 hours after 36–50 and 54 days, respectively. The cattle and another sprayed with the mixture but not exposed to flies showed no signs of poisoning. In a comparison of the duration of effectiveness of similar

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deposits of γ BHC from the two treatments; samples of hair from two yearlings sprayed with the mixture under pressure as before gave complete knockdown of heavily engorged *Stomoxys* in petri dishes in 44 and 51 minutes and complete mortality in 24 hours after four weeks, whereas treated hair from two yearlings heavily sprayed on a small area of the body with 1 per cent. γ BHC in emulsified solution needed over 200 minutes to give complete knockdown after two weeks, and gave only 70 and 85 per cent. mortality after three weeks and 20 and 25 per cent. after four. The mixture still gave 30 per cent. mortality after nine weeks.

However, treatment of two cows, one with the emulsion to give a deposit of about 2 gm. γ BHC and the other with the pressurised spray to give 20 gm. each of γ BHC and Aroclor, and subsequent periodical examination of the milk showed that a heavy initial concentration was built up from the mixture. One, three, seven, 14 and 21 days after treatment, there were 0·85, 0·27, 0·1, 0·05 and 0·03 parts γ BHC per million in the milk of the cow treated with the emulsion and 8·4, 4·6, 2·7, 0·74 and 0·44 p.p.m. in the milk of the cow treated with the mixture, indicating that γ BHC was absorbed from the latter deposit for about seven days. The high initial concentration in the milk and the continued absorption for a week may have been due to the fact that the amount of γ BHC in the mixture exceeded the amount soluble in the Aroclor. This produces a needle-like bloom that volatilises readily and gives rapid kill of insects, and the vapours near the skin may have been readily absorbed. Also, the animal may have been wetted more thoroughly than was intended. Increasing the ratio of Aroclor to γ BHC would eliminate crystal formation and might decrease absorption of γ BHC. It is concluded from the high initial concentration in milk that further work is necessary before this type of treatment can be recommended for use on dairy or beef cattle.

Hesse (A. J.). **A Revision of the Bombyliidae (Diptera) of southern Africa. Part III.**—*Ann. S. Afr. Mus.* **35** pt. 2 pp. 465–931, 2 pls., 112 figs. Cape Town, 1956.

The area covered by this revision comprises parts of Northern and Southern Rhodesia and Mozambique, and the whole of the Union of South Africa, South-West Africa and Bechuanaland. This part is noticed because the genera dealt with in it include *Thyridanthrax*, several members of which are parasitic in puparia of *Glossina*. Keys are given to the adults of species represented in collections from southern Africa, together with descriptions of them and also of two new species from East Africa. The latter are *T. burtti*, sp. n., a parasite of *Glossina austeni* Newst. in Kenya, and *T. alliopterus*, sp. n., a parasite of *G. brevipalpis* Newst., *G. pallidipes* Aust. and *G. austeni* found in Tanganyika and Kenya. Another new species is *T. brevifacies*, which is the parasite of *G. brevipalpis*, *G. pallidipes* and *G. austeni* in Zululand referred to in papers already noticed [*R.A.E.*, B **44** 91, 94, 95]. It has also been taken in Natal and the Eastern Cape, where *Glossina* does not occur. The parasites of *G. morsitans* Westw. are *T. lloydi* (Aust.) in Northern and Southern Rhodesia, *T. beneficus* Aust. in Southern Rhodesia, and *T. transiens* Bez., *T. abruptus* (Lw.) and *T. lugens* (Lw.), which are distributed over southern Africa much more widely than the genus *Glossina*. *T. abruptus* also parasitises *G. pallidipes* and *G. brevipalpis*, and a male and a female that appear to be *T. lugens* were bred from *G. austeni* in Mozambique. Two species of *Thyridanthrax* have hitherto been confused under the names *T. abruptus*, *T. lugens* and *T. lineus* (Lw.), and it has been considered that *abruptus* and *lineus* represent distinct species [**17** 212; **21** 198, 201; **33** 58] and that *lugens* is a synonym of *abruptus* [**17** 212]. It is

here concluded, however, that *lineus* (of which the type is a clear-winged male) is a synonym of *abruptus* (of which the type is a female with infuscated wings), and that *lugens* (both sexes of which have infuscated wings) is distinct. Two females thought to be *T. salutaris* Aust., which was described from a single male bred from *G. morsitans* in Nyasaland [**17** 212], have been reared from puparia of the same species in Southern Rhodesia.

Crosskey (R. W.). **Observations on the Bionomics of Adult *Simulium damnosum* Theobald (Diptera, Simuliidae) in Northern Nigeria.**—*Ann. trop. Med. Parasit.* **49** no. 2 pp. 142–153, 4 graphs, 12 refs. Liverpool, 1955.

Data are given on the biting habits, seasonal abundance, density and dispersal of the adults of *Simulium damnosum* Theo. as observed at Kudaru near the Galma River in Zaria Province, Northern Nigeria [*cf. R.A.E.*, B **43** 121], between February and August 1952 and May 1953 and January 1954. Some reference is also made to observations made at other foci in Northern Nigeria and a focus on the Oji River in the Eastern Region, and notes are included on the behaviour of the fly in southern Nigeria. At Kudaru, *S. damnosum* feeds voraciously on man, but it has also been seen to attack donkeys and dogs. Both scent and sight seemed to be involved when a host was attacked, and dark surfaces were attractive. No males were caught among the flies coming to bite man, though the sexes emerged in equal numbers. Engorgement usually took 4–6 minutes. Most bites were received on the lower legs and feet, even if the subject was lying down. This distribution seemed to be correlated with the quantitative distribution of the microfilariae of *Onchocerca volvulus* in the skin of people suffering from onchocercosis of moderate intensity. The females bit throughout the day from soon after sunrise until twilight began. In detailed observations on two days in September, the number biting increased gradually during the morning and declined in the afternoon with little or no mid-day trough in the cycle. This may not apply elsewhere in Northern Nigeria or at other times of the year. Bites occurred almost anywhere out of doors (preferably in slight shade and on somewhat humid overcast days) and occasionally in houses but rarely in native huts. The flies were usually most numerous near their breeding grounds, but dispersed into savannah woodland towards the end of the peak season, and were taken biting on rocky or grassy hills. Few were found near rivers where there was no fringing forest. At the Oji River, where the fringing forest is very dense, they bit only in the open grassy places, particularly at the junction of forest and grassland. The number biting per man-hour was often no greater at river crossings, where the natives gather, than in the woodland several miles from the nearest farms, villages or river crossings.

Northern Nigeria has a well-marked wet season from May to October or November, and a dry season during which many rivers dry up. *S. damnosum* survives the dry season in the larger rivers, but the adults become very scarce. Their numbers increase rapidly as soon as the rains begin, fall in August when the rivers are in flood, and rise again in September when river levels fall. In southern Nigeria and the British Cameroons, where the dry and wet seasons are much less pronounced, *S. damnosum* is abundant throughout the year. None of the few adults caught during the dry season in the north harboured *O. volvulus*, but of 125 dissected in February 1954 (a dry-season month) at the Oji River, 12 were infected, four with infective forms in the mouth-parts. These findings on seasonal distribution are compared with those of other workers elsewhere [**41** 38;

42 145]. Areas in which a definite seasonal prevalence is shown lie away from the Equator and have well-marked wet and dry seasons.

The conditions in which fly counts should be made if they are to be used to compare densities at different foci or on different days at a given focus are discussed. It is considered that the numbers of flies caught per man-hour at different foci can be useful for comparative purposes if the catches are made at the time of maximum activity. To assess density variation in any one focus from day to day, it is thought best to make all-day catches and compare the absolute figures resulting. During daily collections at Kudaru from 7th July to 2nd August (excluding Sundays), in which 10,940 flies were caught, the daily catches (36 man-hours) varied from 257 to 835. The catch was always higher on days that followed flooding of the Galma River than when the river was high but not excessively swollen. It is suggested that increased oxygenation in the flooded river accelerates pupal development, with the result that adults emerge in greater numbers after flooding. The density of the flies decreases with increasing distance from the river in which they breed. However, flies were caught up to seven miles from the breeding rapids in the Galma River in densities of up to three per man-hour in 1953, and 16·5 per cent. of the people examined in villages more than ten miles from the breeding grounds have been found to have onchocercosis. Flies disperse widely in woodland during the rains.

Gillett (J. D.). **Further Studies on the Biting Behaviour of** *Aëdes* (*Stegomyia*) *simpsoni* **Theobald in Uganda.**—*Ann. trop. Med. Parasit.* **49** no. 2 pp. 154–157, 9 refs. Liverpool, 1955.

In September 1951, studies were made of the biting habits of *Aëdes simpsoni* (Theo.) in parts of the Bunyoro area of Uganda in which the rate of immunity from yellow fever in man was very low, possibly because the mosquito is represented by a race that does not attack man [*cf. R.A.E.*, B **41** 161]. As available evidence indicates that where *A. simpsoni* bites man it does so in the open and in the daylight [*cf.* **34** 28], one standard daylight catch lasting 12 hours was made in each of eight plantations in which larvae and pupae were found in water in the axils of plants. The percentages of water-containing axils in which they were found and the plants concerned in each plantation are shown in a table. Only one adult of *A. simpsoni* was caught biting man in the 96 hours, though the percentages of water-containing axils with larvae or pupae were of the same order (32·5–43·3) in five of the plantations as that found in Bwamba (36·5), where the species bites man. Seven of the plantations were at altitudes of 3,200–3,600 ft., rather lower than those at which non-anthropophilous populations were previously known to occur [*cf.* **41** 161]. It appears reasonable to regard the anthropophilous and non-anthropophilous populations as separate races, even though it has not been possible to differentiate them morphologically.

Gillies (M. T.). **Notes on the Eggs of some East African** *Anopheles*.—*Ann. trop. Med. Parasit.* **49** no. 2 pp. 158–160, 3 figs., 4 refs. Liverpool, 1955.

Notes are given on the morphology of eggs laid by females of *Anopheles wilsoni* Evans, *A. machardyi* Edw., *A. rhodesiensis* Theo., *A. seydeli* Edw. and *A. lecsoni* Evans from Tanganyika, and of *A. keniensis* Evans from the type locality (the Taveta forest) in Kenya, and from Tanganyika. The eggs of the first four species had not previously been described. The eggs of

A. keniensis had 14–17 float chambers and the chorion was covered completely with uniform bosses. They appeared to be identical with those of *A. demeilloni* Evans as figured by De Meillon [*R.A.E.*, B **36** 59]. The relationship of these two species [*cf.* **21** 204] therefore needs further study, and doubt is cast on the identity of the mosquito from the Kaimosi forest, Kenya, the eggs of which were described as those of *A. kenicnsis* in a paper already noticed [**34** 92] and stated to have an average of 20 float chambers, uneven bosses on the chorion and large spots of black pigment scattered over the general surface.

Desowitz (R. S.) & Fairbairn (H.). **The Influence of Temperature on the Length of the developmental Cycle of** *Trypanosoma vivax* **in** *Glossina palpalis*.—*Ann. trop. Med. Parasit.* **49** no. 2 pp. 161–163, 5 refs. Liverpool, 1955.

Adults of *Glossina palpalis* (R.-D.) that had emerged from pupae kept at 26°C. [78·8°F.] were fed once on a sheep infected with *Trypanosoma vivax* and were then kept in batches of 92 and 85 flies in incubators at mean maximum temperatures of 29 and 22°C. [84·2 and 71·6°F.], respectively, and fed on a series of uninfected sheep after incubation for four or more days. The flies kept at the higher temperature did not infect the sheep on which they fed after four days but infected those on which they fed after five days or more. Those kept at the lower temperature did not infect the sheep after 11 days or less but infected them after 13 days or more.

Lewis (D. J.). **The** *Aëdes* **Mosquitoes of the Sudan.**—*Ann. trop. Med. Parasit.* **49** no. 2 pp. 164–173, 9 maps, 26 refs. Liverpool, 1955.

The distribution in the Sudan of 25 species of *Aëdes* of subgenera other than *Stegomyia* is shown on maps, and new distribution records for these and the eight species of *Stegomyia* known in the area [*R.A.E.*, B **42** 166] are given. Some aspects of distribution and the importance of members of the genus in the Sudan are discussed. The carnivorous larvae of *A. scatophagoides* (Theo.) are doubtless of some use in destroying the larvae of other mosquitos. Many species cause great annoyance by their bites; and others are vectors or potential vectors of yellow fever. West Nile encephalitis has been reported from the Sudan. It can probably be carried by *A. aegypti* (L.) [**43** 71, etc.].

Duke (B. O. L.). **Studies on the Biting Habits of** *Chrysops*. **I. The Biting-cycle of** *Chrysops silacea* **at various Heights above the Ground in the Rain-forest at Kumba, British Cameroons.**—*Ann. trop. Med. Parasit.* **49** no. 2 pp. 193–202, 5 graphs, 6 refs. Liverpool, 1955.

When Crewe & O'Rourke studied the biting-cycle of *Chrysops silacea* Aust. at Kumba, British Cameroons [*R.A.E.*, B **41** 27], they worked in a volcanic gorge leading out of a crater lake where the lighting conditions were unique [*cf.* **43** 42]. Improved methods of erecting scaling-ladders against vertical forest trees subsequently made it possible to investigate all levels up to and above the canopy in other parts of the rain-forest, and observations were made between 27th March and 9th June 1954 on the biting-cycle in an emergent tree above the canopy (130 feet), in the canopy (92 feet), in the relatively open layer between the canopy and the sapling layer (28 feet), and at ground level among the saplings and shrubs. The chosen trees were

growing on a breeding-site at the bottom of a gully. The platforms were out of sight of one another. No fires were lit, and no smoking was allowed. One fly-boy served as bait at each station. The catch and the temperature and saturation deficit were recorded hourly at each station, and records of light-intensity were made at 15-minute intervals, on one day for each station, in the following November.

The results are given for the 29 days on which no rain fell during catching hours (7 a.m. to 6 or 7 p.m.). Of the 420 flies taken, 28, 169, 151 and 72 were caught at 130, 92 and 28 feet and at ground level, respectively. Biting above the canopy appeared to be random from about 8 a.m. to 5 p.m. It is concluded that this sunlit layer is seldom visited, as resting places and potential blood-meals are scarce and temperature and saturation deficit are too high and light too intense throughout most of the day. The few adults taken had probably invaded the higher layer because they had sensed the presence of the fly-boy. At all three levels within the forest, the daily rise in biting density was delayed until some time after sunrise (9–10 a.m. in the canopy and noon or later at the lower levels). In the canopy, there was a peak in biting at about noon and another at 3–4 p.m., with a distinct drop at 1–2 p.m. At 28 feet and ground level, there was one peak at about 3 p.m. At all three levels, but particularly the two higher ones, biting persisted until near sunset, when it fell off sharply.

The relationship between these variations and physical conditions prevailing at different heights was studied. Curves of light intensity appeared, despite fluctuations, to be symmetrical about the sun's zenith. They could not therefore explain the biting-density curves, which, at all four stations, were asymmetrical about the sun's zenith. The temperature and saturation-deficit curves started at a low level early in the morning at all stations, rose steadily through the day to reach a peak at about 3 p.m. and fell towards evening. The higher the station above the ground, the higher and more sharply the curves rose. The differing and eccentric biting-density curves at the three stations in the forest may be the result of inhibition of biting, even at suitable light intensity, until temperature and saturation deficit have risen to a certain level, which is reached earlier in the canopy than lower down. The longer persistence of high temperatures and saturation deficits at the two higher stations may account for the more prolonged biting activity at those stations in the evening. The decrease in biting density between noon and 2 p.m. in the canopy may be due to some downward migration, as conditions lower down become more favourable. However, the fact that later in the afternoon, when biting densities reach their maximum at the lower stations, the total number of flies biting is greatest and catches in the canopy rise again shows that migration downward is not the full explanation. Since the two leafy strata are the main resting places, some of the population in the sapling layer may migrate upwards when released from inhibition of biting in the afternoon.

Kershaw (W. E.), Lavoipierre (M. M. J.) & Beesley (W. N.) **Studies on the Intake of Microfilariae by their Insect Vectors, their Survival, and their Effect on the Survival of their Vectors. VII. Further Observations on the Intake of the Microfilariae of** *Dirofilaria immitis* **by** *Aëdes aegypti* **in Laboratory Conditions: the Pattern of the Intake of a Group of Flies.**—*Ann. trop. Med. Parasit.* **49** no. 2 pp. 203–211, 5 graphs, 4 refs. Liverpool, 1955.

The following is substantially the authors' summary. The results of experiments that compared the actual and expected intakes of microfilariae of *Dirofilaria immitis* from a dog by individual females of *Aëdes aegypti* (L.)

[*R.A.E.*, B **42** 202] are re-examined in such a way as to determine the pattern of the intake of a group of mosquitos [*cf.* **44** 180]. It is shown that, though there are individual variations in a group, the actual intake, the expected intake (both of which are measures of the intake of microfilariae), the population exposed and, in the conditions of the experiment, the population at risk (which are measures of the canine reservoir) are all related, and that their relations can be analysed mathematically. A group of mosquitos feeding to repletion takes in a little more than half as many microfilariae as would be expected from the size of the individual blood-meal and the concentration of microfilariae in the peripheral blood of the host. Since ingestion of large numbers of microfilariae results in death of the mosquito, those individuals that are likely to live long enough to support development to the infective form take in no more than about half the number taken by the whole group.

Potts (W. H.). **A new Tsetse-fly from the British Cameroons.**—*Ann. trop. Med. Parasit.* **49** no. 2 pp. 218–226, 1 pl., 4 figs., 5 refs. Liverpool, 1955.

Glossina nashi, sp. n., a member of the group of *G. fusca* (Wlk.), is described from two males and three females collected in hilly forest country in the southern part of the British Cameroons in 1948–53. The holotype male was taken on cattle, and it and one of the females were seen to be active in the daylight, in the late afternoon and the morning, respectively.

Hocking (K. S.) & Yeo (D.). **Aircraft Applications of Insecticides in East Africa. XI. Applications of a coarse Aerosol to control** *Glossina morsitans* **Westw. at Urambo, Tanganyika, and** *G. morsitans* **Westw. and** *G. pallidipes* **Aust. in Lango County, Uganda.**—*Bull. ent. Res.* **47** pt. 4 pp. 631–644, 4 maps, 10 refs. London, 1956.

In this paper, which belongs to a series [*R.A.E.*, B **44** 196, etc.], two experiments are described in which aerosols were applied from aircraft to areas of savannah woodland infested with *Glossina* spp. The aerosols, which were formed from oil solutions of DDT or BHC [**42** 152] had mass median diameters of about 60μ and were applied, if possible, so that each section of woodland was treated almost fortnightly for a period covering rather more than two average pupal periods, at a nominal dosage of 0·25 gals. (equivalent to 0·2 lb. p,p′DDT or 0·03 lb. γ BHC) per acre [*cf.* **42** 24]. The aircraft was flown as close as possible to the top of the canopy.

In the first experiment, in which both DDT and BHC were used in semi-isolated woodland at Urambo (Tanganyika) in 1952, populations of *G. morsitans* Westw. were reduced by 95 per cent. This reduction was somewhat lower than that achieved in many other experiments, probably because the proposed cycle of applications (six at intervals of 16–17 days) could not be maintained. The interval between the fourth and fifth applications over an important part of the area had to be extended to 20–26 days and the sixth was also delayed and was not complete. The fly populations then increased fairly rapidly to levels not very different from those prevailing before treatment. In this respect, the experiment was a failure. The rapid build-up was almost certainly due to immigration into the treated blocks across clearings, some of which were no more than 880 yards wide.

The second experiment, in Lango County, Uganda, in 1953, comprised seven applications of DDT at intervals of 15–18 days and an eighth on part of the area and was highly successful. A population of *G. morsitans* was

reduced by over 99·95 per cent., and a small population of *G. pallidipes* Aust. was eradicated. It is likely that no stable population now exists in the area, as only a very few flies were caught there during the ensuing year and these may have come from other infested woodland. The continued success of the experiment is attributed to the effective isolation of the area. In spite of it, the Uganda government were unwilling to deal with the whole fly-belt in the same way on account of the cost (about £1,000 per sq. mile of treated woodland).

Bertram (D. S.) & McGregor (I. A.). **Catches in the Gambia, West Africa, of *Anopheles gambiae* Giles and *A. gambiae* var. *melas* Theobald in Entrance Traps of a baited portable wooden Hut, with special Reference to the Effect of Wind Direction.**—*Bull. ent. Res.* **47** pt. 4 pp. 669–681, 1 pl., 4 graphs, 23 refs. London, 1956.

The following is substantially the authors' summary. A portable wooden hut with two windows, on opposite sides, fitted with traps to catch mosquitos as they entered was tried, with human bait, as a sampling device for mixed populations of *Anopheles gambiae* Giles and *A. gambiae* var. *melas* Theo. in and near Keneba village in the West Kiang district of the Gambia. The two varieties were not differentiated in the catches, but the proportion of *melas* must have been considerable, as the percentages of females with 4-banded palps [*cf. R.A.E.*, B **36** 97, etc.] in the four catches reported in detail ranged from 16·9 to 30·6.

In 18 night catches, between 24th August and 22nd September 1954, 5,901 females were taken in traps, five high catches (642–1,240 females) being made before 3rd September and 13 low catches (27–306 females) between 6th and 22nd September. Possible causes for the different size of catches in the two periods are discussed, with the conclusion that the differences in catch are not simply attributable to erratic functioning of the hut as a trap. Four night catches of 186, 741, 797 and 1,240 females are reported in detail. They reveal that the mosquitos were taken almost exclusively in the leeward trap if the wind persisted from one direction. If the wind was variable or conditions were calm, they were taken in both traps, and entered the traps alternately as the wind shifted in the first instance and perhaps simultaneously in calm. The use of only one trap could therefore give misleading information about the numbers of mosquitos available outside the hut. There is no doubt that, with wind, the mosquitos approached the host in the hut from down-wind. Since much of the catching occurred in darkness, it would seem that the mosquitos were attracted by the emanations of the host and that their approach to the hut was not directed by a visual mechanism controlling up-wind flight. Heavy rain for about seven hours did not prevent flight.

From hourly collections made from dusk to dawn, a curve of activity for the species was obtained resembling the biting-cycle reported by other authors [**35** 67; **36** 98; **37** 177], with the greatest activity between midnight and 6 a.m. All but two of the females were unfed, and the ovaries in a small sample examined were in stage I or II. First entries occurred just before complete darkness in the evening and the last in good light about 30 minutes after sunrise. No male mosquitos were taken in the traps. One female of *A. funestus* Giles, one of *A. rufipes* var. *ingrami* Edw. and 123 of mosquitos of other genera were taken.

The hut, if modified to include a window trap in each of the four walls and a cowl over each window to keep out rain, would be a simple and convenient sampling device for certain types of investigations on the biology and behaviour of *A. gambiae*.

Jordan (A. M.). **A Note on the Parasitisation of the Oöthecae of** *Periplaneta americana* **(L.) by the Chalcid,** *Syntomosphyrum glossinae* **Wtstn. A Correction.**—*Bull. ent. Res.* **47** pt. 4 pp. 683–684, 2 refs. London, 1956.

In 1955, Nash recorded *Syntomosphyrum glossinae* Wtstn., which normally develops in the pupae of *Glossina* spp., as parasitising the oothecae of *Periplaneta americana* (L.) in the fly-breeding room at the West African Institute for Trypanosomiasis Research at Kaduna in 1953 [*R.A.E.*, B **43** 91]. Two Eulophids found on the windows of the same room after the publication of Nash's note proved to be the very similar *Tetrastichus hagenowii* (Ratz.), a world-wide parasite of *P. americana*. During the next few months, six batches of *T. hagenowii* that emerged from cockroach oothecae and two batches of *S. glossinae* from pupae of *G. palpalis* (R.-D.) were subdivided, and half of each batch was put on cockroach oothecae and half on *Glossina* pupae of assorted ages. In no case did *T. hagenowii* parasitise *Glossina* pupae or *S. glossinae* cockroach oothecae, though both successfully parasitised their normal host. It therefore appears that Nash was incorrect in recording *S. glossinae* as attacking *P. americana*, a view with which he agrees.

Lewis (D. J.). *Culex* **Mosquitoes of Subgenera other than** *Culex* **in the Anglo-Egyptian Sudan.**—*Ann. Mag. nat. Hist.* (12) **7** pp. 7–12, 7 maps, 13 refs. London, 1954. **The** *Culex* **Mosquitos of the Sudan.**—*Bull. ent. Res.* **47** pt. 4 pp. 703–721, 11 maps, 41 refs. London, 1956. **Some Mosquitos of the Sudan.**—*T. c.* pp. 723–735, 16 maps, 25 refs.

In the first paper, the distribution in the Sudan of 17 species of *Culex* of subgenera other than *Culex* is shown on maps, and distribution records additional to those mentioned in a monograph and papers already noticed [*R.A.E.*, B **29** 114; **34** 188; **38** 164] are given.

Additional notes on some of these species are included in the second paper, which comprises mainly a list of 28 species of the subgenus *Culex*, two of them represented by two subspecies and one by two varieties, with local distribution maps for the members of this subgenus, taxonomic notes on a few of them and records of new localities. Some aspects of distribution are discussed. Several of the species commonly bite man, including *C. poicilipes* (Theo.) and *C. antennatus* (Beck.), which attack in vast numbers near swamps, *C. pipiens* L. (a name used to include *C. p. molestus* Forsk. [*cf.* **41** 206–207]) and *C. p. fatigans* Wied., which, however, have a limited distribution, and sometimes *C. univittatus* var. *neavei* Theo. Species of *Culex* may be involved in the maintenance of yellow fever in the Sudan, perhaps by transmitting it among mammalian hosts other than man. The virus of West Nile encephalitis has been reported from many localities, and *C. antennatus*, a suspected vector [*cf.* **43** 50], is common in a few of them and other mosquitos occur in most. *C. pipiens*, the vector of *Wuchereria bancrofti* in Egypt [**20** 159] and *C. p. fatigans*, which transmits it in some other parts of Africa, are rare in or absent from areas of the Sudan in which the disease is known.

In the third paper, the Culicidae of the Sudan of genera other than *Anopheles* [*cf.* **44** 196], *Aëdes* [**45** 21] and *Culex* are similarly dealt with. They comprise *Dixa lunata* Edw., three species of *Chaoborus* and 46 species (two of them represented by two varieties) of nine genera of Culicinae. *Chaoborus anomalus* Edw. breeds in the Nile and forms a small proportion of the Diptera, chiefly Chironomids, that cause great annoyance every winter at Khartoum [*cf.* **44** 66, 123]. *Mansonia* (*Taeniorhynchus*) *africana* (Theo.) and *M.* (*T.*) *uniformis* (Theo.) bite man in vast numbers in the Sudd region.

They and *Eretmapodites silvestris conchobius* Edw. may play some part in the transmission of yellow fever [**35** 105; **41** 190].

Iyengar (M. O. T.). **Filariasis in Thailand.**—*Bull. World Hlth Org.* **9** no. 6 pp. 731–766, 3 figs., 2 refs. Geneva, 1953. (With a Summary in French.)

Iyengar (M. O. T.) & Menon (M. A. U.). **The Mosquitos of south Thailand; with an Appendix by P. F. Mattingly.**—*Bull. ent. Res.* **47** pt. 4 pp. 785–795, 8 figs., 13 refs. London, 1956.

Endemic filariasis in Siam, which is the subject of the first paper, is restricted to the peninsular part of the country (south of lat. 12°N.) and largely to the flat, low-lying rural areas in the eastern coastal belt, and it is caused by *Wuchereria malayi*. In a survey of a large number of villages between November 1951 and February 1952, 863 of 4,112 people examined had microfilariae in the peripheral blood. Lists are given of the mosquitos collected during the investigation, which comprised 63 species, including six species of *Mansonia*, 13 of *Anopheles* and two subspecies of *A. hyrcanus* (Pall.), and of those examined for larvae of *W. malayi*, which were collected in dwellings and comprised 2,499 females representing all the species of *Mansonia*, 11 species of *Anopheles* and 22 species of other genera. Normally-developing larvae of *W. malayi* were found in 9 of 52 females of *M. annulifera* (Theo.), 5 of 44 of *M. uniformis* (Theo.), 28 of 317 of *M. indiana* Edw., 9 of 131 of *M. longipalpis* (Wulp), 42 of 358 of *A. barbirostris* Wulp, 3 of 81 of *A. hyrcanus nigerrimus* Giles, 3 of 83 of *A. h. sinensis* Wied., 1 of 25 of *A. albotaeniatus* (Theo.) and 1 of 30 of *A. umbrosus* (Theo.). These vector species occur in large numbers and breed in the extensive marshes near the villages. All feed readily and primarily on man and rest mainly in dwellings.

The practicability of various means of controlling filariasis are discussed. Control of vectors in the larval stage would be both difficult and expensive, but spraying dwellings with DDT would be feasible. The method was tried experimentally, and 21 days after the interior walls of all dwellings in a village had been sprayed with DDT at 170 mg. per sq. ft., the incidence of the vectors had been reduced from 44·8 to 1·3 per man-hour catch as compared with a fall from 27·4 to 10·8 in a control area. Vectors caught in the experimental area showed 7·6 per cent. infection before spraying and none 21 days after it, whereas infection was continuing in the control area. Spraying in June–July and again in December–January with DDT at 200 mg. per sq. ft. is suggested. It could be supplemented by removal of aquatic vegetation and draining or reclamation of marshes, where this is feasible.

In the second paper, corrections are made to the identification or nomenclature of four of the species of mosquitos included in the previous list, taxonomic notes are given on eight species, two additional species of *Anopheles* are recorded, the larva of *Uranotaenia bimaculiala* Leic. is described for the first time and the fourth-instar larva of *U. longirostris* Leic. is also described. As some of the species mentioned in the paper are represented in the British Museum by series of syntypes, P. F. Mattingly has chosen and marked lectotypes as recorded in the appendix.

Lea (A. O.), Knierim (J. A.), Dimond (J. B.) & DeLong (D. M.). **A preliminary Note on Egg Production from Milk-fed Mosquitoes.**—*Ohio J. Sci.* **55** no. 1 pp. 21–22, 4 refs. Columbus, Ohio, 1955.

Because of the cost and trouble of rearing rabbits to provide blood-meals for mosquitos, investigations on substitute foods were made at the Ohio State University. A colony of *Aëdes aegypti* (L.) was maintained for nine

months when the only food for the adults was a mixture of citrated ox blood and honey (9:1) on a cotton pad put on top of the cage or suspended in it. Egg production seemed equal to that obtained with a rabbit as host. The same technique originally gave poor results with *Anopheles quadrimaculatus* Say, but it had been found that temperature plays a considerable part in attracting females of this species to the host, and further experiments showed that they would feed readily on citrated ox blood on cotton (without honey) if the blood was maintained at about 93–95°F. This was done by fixing a U-tube into one side of the cage with the two ends outside. Blood-soaked cotton was wrapped round the tube and maintained at the desired temperature by water flowing through it at 115–120°F. In subsequent studies on the possibility of using a more readily available material as an egg-producing agent, skimmed milk was successfully substituted for blood with both species. *Anopheles quadrimaculatus* also laid viable eggs when fed on a mixture of proteose-peptone, liver concentrate and casein hydrolysate. The methods used were those described for blood.

Steinhaus (E. A.) & Smith (R. F.). Ed. **Annual Review of Entomology. Volume I.**—9 × 6 ins., ix + 466 pp., illus., many refs. Stanford, Cal., Annual Reviews, Inc., 1956.

This is the first of a proposed series of annual volumes, the object of which is to publish authoritative and concise reviews of subjects of current entomological interest. Each review is to present a critical analysis of recent literature, and so far as possible an appraisal of the present status of the subject. Those in this first volume, all of which are noticed elsewhere [*R.A.E.*, A **45** 70], include: **Arthropod Resistance to Chemicals,** by W. M. Hoskins & H. T. Gordon (pp. 89–122, 1 graph, 158 refs.), in which the subjects discussed are diversity in reaction to a toxicant as a basic characteristic of a population, the differences between susceptible and resistant strains as revealed by the dosage-mortality curve, and the use of the slope of the log-probit line as a measure of heterogeneity, certain genetic aspects of heterogeneity, and the biochemical mechanisms known to be concerned in resistance to insecticides; **The Mode of Action of Insecticides,** by C. W. Kearns (pp. 123–148, 3 figs., 137 refs.), in which the insecticides discussed are DDT, BHC, pyrethrum with synergists, and the organophosphates; **The Chemistry of Insecticides,** by Hubert Martin (pp. 149–166, 66 refs.), in which the materials considered are DDT and its analogues, the hexachlorocyclopentadiene group (with which γ BHC is included), the pyrethrin group, and the organophosphates; **Repellents,** by V. G. Dethier (pp. 181–202, 144 refs.), which includes a brief survey of compounds and mixtures found effective against mosquitos, ticks and Trombiculids, but is mainly concerned with the design of experiments, the evaluation and control of variables encountered in them, the chemical basis and nature of repellency, the repellent effect of certain insecticides, and the mode of action of repellents on chemosensory systems; **Nonbiting Flies and Disease,** by D. R. Lindsay & H. I. Scudder (pp. 323–346, 187 refs.), in which the principal diseases considered are poliomyelitis and bacillary dysentery, others including the Coxsackie viruses, infectious conjunctivitis, yaws and myiasis, and methods of evaluating fly populations and problems of fly control are also discussed; and **Veterinary and Medical Acarology,** by H. S. Fuller (pp. 347–366, 87 refs.), which, apart from a brief note on Oribatids as hosts of cestodes of ruminants, is almost entirely concerned with investigations on the relations of ticks and mites to diseases to which man is subject.

An index to the authors whose work is reviewed and one to subjects are appended.

Baker (E. W.), Evans (T. M.), Gould (D. J.), Hull (W. B.) & Keegan (H. L.). **A Manual of Parasitic Mites of medical or economic Importance.**—9¼ × 6 ins., [5+] 170 pp., 59 figs., refs. New York, N.Y., Nat. Pest Control Ass., Inc., 1956. Price $4.25 post paid.

A summary, compiled from the literature, is given of information on the morphology, life-cycle, hosts, and control if any has been devised, of mites that are of medical or veterinary importance or are frequently encountered because they are parasitic on animals in which man is interested. There is also a key to the included species (or genera or families where no smaller division is considered). The references to the literature in question are appended to the discussion of each species or group.

Budnik (V. S.). **New Data on the Mechanism of Transmission of the causal Agent of Nuttalliasis of Horses by the Tick** *Dermacentor marginatus* **Sulz.** [*In Russian.*]—*Veterinariya* **32** no. 8 pp. 36–43, 1 ref. Moscow, 1955.

The experiments described were carried out in the Province of Saratov during 1948–51 to study the biological relations between *Nuttallia equi* and its vector, *Dermacentor marginatus* (Sulz.), with particular reference to its hereditary transmission from generation to generation in the tick and its transmission from horse to horse by the adult males. In the first experiment, eggs laid by eight ticks that had engorged on an infected horse were examined microscopically, and *N. equi* was found in eggs of one of them. Ticks of the F_1 generation reared from the remaining eggs of this female became adult in August 1948 and were kept until the following February, when, at a temperature of 16°C. [60·8°F.], six females and four males were placed under a bandage on a healthy colt and transmitted the disease to it. *N. equi* was shown to be present in eggs laid by four of the females, which had been found engorged under the bandage after 10–11 days, and an F_2 generation was reared from them. Adults of this generation, however, failed to infect two colts on which they engorged, though some of them subsequently laid eggs in which degenerate forms of *N. equi* were found. Both the colts were then shown to be susceptible, one being infected by blood inoculation and the other by male ticks removed from a carrier of the causal agent.

In another experiment, *N. equi* was found in eggs of only one of 12 females that had engorged on a naturally infected colt, and 40 adults that were the offspring of this female failed to infect a healthy colt. The fact that the naturally infected colt was infected with *N. equi* and not with *Piroplasma caballi* was shown by examination of the blood and by a subsequent test in which it proved susceptible to *P. caballi* transmitted by *D. marginatus*. The colt that the ticks had failed to infect subsequently became infected with *N. equi* when kept for four months on a pasture known to harbour infected ticks. A few weeks before it showed symptoms of the disease, 18 engorged males and 15 engorged females of *D. marginatus* were collected from it. The males transmitted *N. equi* to a healthy colt on which they were placed one day after they were collected, but repeated examinations of the eggs laid by the females failed to show infection. Moreover, no evidence of hereditary transmission was obtained in other series of tests involving the eggs or offspring of 269 females that had engorged on six infected colts. On the other hand, transmission from an infected to a healthy colt by males was obtained in each of three further experiments, and it appeared that such transmission was not merely mechanical, since the intervals between the feeds, during which the ticks were kept at 26–27°C. [about 80°F.], were 17 and 27 days in two of the tests. It is concluded that transmission by the

offspring of infected females is not an important factor in the spread of *N. equi*, but the probable importance of transmission by males has been supported by the finding, under both experimental and field conditions, that the males often pass from horse to horse in their search for females and feed repeatedly while doing so.

Abramov (I. V.). **A new Type of Transmission by Vector Ticks of the causal Agent of Nuttalliasis of Horses** (*Nuttallia equi*, **Laveran, 1901**). [*In Russian.*]—*Veterinariya* **32** no. 8 pp. 43–45. Moscow, 1955.

Blood from a horse that had been infected in June 1948 with the strain of *Nuttallia equi* that occurs in the southern part of the Soviet Union and had been transmitted to it by *Hyalomma marginatum* Koch (*plumbeum*, auct.) was injected into a colt on 1st October 1954. The colt showed typical symptoms of infection, including fever, on 9th October. Uninfected adults of *Dermacentor marginatus* (Sulz.) were placed on it on 12th and 14th October. Some were removed on 16th October, when they had begun to feed but showed hardly any visible signs of engorgement, and were kept for 28 days at 18–22°C. [64·4–71·6°F.], after which six females and nine males were placed on a healthy horse, to which most of them were attached by the next day. Three fully engorged females dropped after 13 days, and the other ticks were removed four days later (on 29th November). The horse became infected, but its symptoms did not include any marked temperature reaction, and the parasites, which could be found in its blood from 26th November onwards, were predominantly of the medium and small size characteristic to the strain of *N. equi* of the middle zone.

These experiments provide support for the view that the adult ticks, especially the males, are of importance in the transmission of *N. equi* from horse to horse [*cf.* preceding abstract]. They also show that the southern strain of *N. equi* can survive in a horse for more than six years, and indicate that it may change its main characteristics to those of the strain of the middle zone as a result of passage through *D. marginatus*.

Akatov (V. A.). **Duration of Survival of Trichomonads in** *Musca domestica* **L.** [*In Russian.*]—*Veterinariya* **32** no. 8 p. 84, 1 fig. Moscow, 1955.

To ascertain whether *Musca domestica* L. could be concerned in the transmission of Trichomonads of cattle from one animal to another, batches of flies were allowed access to a cup of exudation containing motile Trichomonads for an hour and the contents of the digestive tracts of some of them were subsequently examined. It was thus shown that the Trichomonads could survive in the flies for up to eight hours after their ingestion and so could possibly be transmitted by them.

Moorefield (H. H.). **Purification of DDT-dehydrochlorinase from resistant House Flies.**—*Contr. Boyce Thompson Inst.* **18** no. 8 pp. 303–310, 2 figs., 16 refs. Yonkers, N. Y., 1956.

It has been shown that the dehydrochlorination of DDT in house-flies (*Musca domestica* L.) is accomplished enzymatically [*R.A.E.*, B **42** 6], and also that, in comparative assays, the presence of the enzyme, DDT-dehydrochlorinase, is correlated with the level of tolerance in fly populations showing resistance to DDT and cannot be detected in susceptible flies. Further evidence that metabolism is associated with acquired tolerance to DDT in house-flies was supplied by the finding that DDT synergists act by inhibiting

the detoxifying enzyme [*cf.* **43** 28; **44** 100]. The work described in this paper, of which the following is the author's summary, was undertaken to purify the enzyme.

A fractionation procedure has been developed to purify the detoxication enzyme, DDT-dehydrochlorinase, from DDT resistant house flies. The method consists of acetone powdering the adult insects, purification by ammonium sulfate precipitation, dialysis, adsorption with activated charcoal and salt concentration of the resultant protein solution. Electrophoretic and ultracentrifugational studies on the final, highly active preparations present evidence of only four major protein components. Preliminary data on a novel purification technique are presented in which DDT-dehydrochlorinase, a glutathione activated enzyme, is protected by thiourea and nonspecific protein eliminated through a series of freeze-thaw manipulations.

Bradbury (F. R.) & Standen (H.). **The Fate of γ-Benzene Hexachloride in normal and resistant Houseflies. II.**—*J. Sci. Fd Agric.* **7** no. 6 pp. 389–396, 5 graphs, 9 refs. London, 1956.

Details are given of quantitative radio-chemical studies on the amounts of water-soluble metabolites produced by house-flies (*Musca domestica* L.) exposed to ^{14}C-labelled isomers of BHC [*cf. R.A.E.*, B **43** 187–188]. Flies of a normal strain or a strain resistant to γ BHC were kept in batches of 50 for 24 hours in flasks of 250 ml. capacity treated with 200 μg. of the α, β, γ or δ isomers, so that they were continuously exposed to a saturated vapour of the chemical, or were kept for 15 minutes in petri dishes on filter paper treated with the α or γ isomer at 11 μg. per sq. cm. and then for up to 24 hours in clean flasks. The flies exposed to the vapours for 24 hours picked up 3–4 μg. each of the α, γ and δ isomers, but only 1·5–2·5 μg. of β isomer, probably because of its lower vapour pressure. The amount of material inside the flies soluble in carbon tetrachloride, which for the γ isomer has been shown to be unchanged BHC, was greatest for the δ isomer, the quantities in μg. per fly of the normal and (in brackets) resistant strains when the flies were of mixed sex being 2·25 (1·60) for δ, 0·98 (0·34) for γ, 0·65 (0·46) for β, and 0·44 (0·15) for α. The ratio of the amount in flies of the normal strain to that in flies of the resistant strain varied from less than two for the δ and β isomers to 3–4 for the α and γ isomers. The four isomers were all converted to water-soluble metabolites. The amounts of the latter produced per fly were 2–3 μg. with the α and γ and 1·75 μg. or less with the δ and β isomers. There was an appreciable "residue" of absorbed radio-activity not extractable by carbon tetrachloride or by water [*cf.* **43** 188], which was bound in the insect tissue and was recovered by combustion of the fly body after the extraction processes. Including this residue, nearly all the BHC picked up was accounted for.

The experiments in which the flies were exposed for 15 minutes showed that BHC was metabolised more rapidly by flies of the resistant than by those of the normal strain. Resistant flies also absorbed less. In the course of 24 hours, almost all the absorbed dose of the α isomer, which is non-toxic, was converted to water-soluble material or unextractable residue, both by normal and resistant flies. The combined effect of reduced absorption and increased decomposition was to reduce the amount of γ BHC in flies of the resistant strain to one-quarter of that in flies of the normal strain four hours after exposure for 15 minutes. It is concluded that both properties contribute to the resistance of the flies to poisoning by γ BHC. The process of conversion of insecticide to metabolite proceeded smoothly despite the mounting death rate. It appears therefore that the biochemical conversion process is continued unaffected by the physiological changes

regarded as criteria of death (absence of all movement when observed in bright light). It was shown by washing the flasks that the water-soluble material was excreted. Flies of the resistant strain excreted more of the metabolite of γBHC than normal flies, presumably on account of the toxic action of the insecticide on the latter. Subdivision into head, thorax and abdomen showed the metabolite predominantly in the abdomen, which is to be expected in a detoxication process leading to excreted products.

Radeleff (R. D.), Woodard (G. T.), Nickerson (W. J.) & Bushland (R. C.). **The acute Toxicity of Chlorinated Hydrocarbon and organic Phosphorus Insecticides to Livestock.**—*Tech. Bull. U.S. Dep. Agric.* no. 1122, [1 +] 46 pp., 26 refs. Washington, D. C., 1955.

The results are given of studies of the acute toxicity to various kinds of livestock (calves, lambs, kids, cattle, sheep, goats, pigs and horses) of 19 organic insecticides applied as sprays to wet the animals thoroughly (or as dips) or administered orally. Over 1,700 animals were used in the tests. The signs of poisoning shown in animals that gave definite evidence of being affected, including those that died, are summarised.

When the insecticides were applied externally to dairy calves 1–2 weeks old, which were far more susceptible and were used in more tests than any other animals, the maximum non-toxic concentration tested and (in brackets) the minimum toxic concentration found, expressed as percentages, were 0·1 (0·25) for aldrin, 0·025 (0·05) for γ BHC, 0·5 (1) for chlordane, 0·1 (0·25) for dieldrin, 0·25 (0·5) for heptachlor, 1 (2) for Strobane [a chlorinated mixture of α-pinene isomers], 0·5–0·75 (1) for toxaphene, 0·2 (0·5) for Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl thiophosphate], 0·05 (0·1) for Diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl thiophosphate], 0·025 (0·05) for EPN [ethyl p-nitrophenyl thionobenzenephosphonate] and 0·5 (1) for malathion. DDT, DDD (TDE), methoxy-DDT (methoxychlor), Dilan [a mixture of 1,1-bis(p-chlorophenyl)-2-nitrobutane and 1,1-bis(p-chlorophenyl)-2-nitropropane] and Perthane [ethyl-DDD (1,1-bis(p-ethylphenyl)-2,2-dichloroethane)] were non-toxic at a concentration of 8 per cent. and Bayer L 13/59 [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate] was non-toxic at 1 per cent., these being the highest concentrations used. Data on Chlorthion [O,O-dimethyl O-3-chloro-4-nitrophenyl thiophosphate] were inconclusive. Parathion was toxic to calves 1–2 years old at 0·01 per cent.

When the insecticides were administered orally to calves 1–2 weeks old, the maximum non-toxic dose tested and (in brackets) the minimum toxic dose found, in mg. per kg., were 2·5 (5) for aldrin, 2·5 (5) for γ BHC, 10 (25) for chlordane, 100 (250) for DDD and DDT, 5 (10) for dieldrin, 15 (25) for heptachlor, 250 (500) for methoxy-DDT, 10 (25) for Strobane, 2·5 (5) for toxaphene, 5 (10) for Bayer L 13/59, 50 (100) for Chlorthion, 0·5 (1) for Diazinon, 0·5 (1) for EPN, 10 (20) for malathion, and 0·25 (0·5) for parathion. One yearling Hereford heifer that received 50 mg. of Bayer 21/199 per kg. died of poisoning, whereas a similar heifer that received 25 mg. per kg. was unaffected. Perthane and Dilan were not tested orally.

Hamon (J.) & Rickenbach (A.). **Contribution à l'étude des culicidés d'Afrique Occidentale. Description d'*Anopheles brumpti* sp. n.**—*Bull. Soc. Path. exot.* **48** no. 3 pp. 342–344, 1 fig., 6 refs. Paris, 1955.

Anopheles brumpti, sp. n., is described from a single female taken attacking man at twilight in the Upper Volta, French West Africa.

Halcrow (J. G.). **Ecology of** *Anopheles gambiae* **Giles.**—*Nature* **177** no. 4520 pp. 1103–1105. London, 1956.

The incidence of malaria in Mauritius was reduced to very small proportions as a result of an intensive house-spraying campaign in 1948–52 that eradicated *Anopheles funestus* Giles [*R.A.E.*, B **43** 5–6], although *A. gambiae* Giles survived and increased in numbers. The reasons for this were investigated over a period of three years. There has never been any direct evidence that *A. gambiae* was a vector in Mauritius. Its host preferences were unknown in 1952, but the high percentage infected with *Wuchereria* (*Filaria*) *bancrofti* [**39** 147] indicated that it was not purely zoophilous. Though most of 1,254 stomach smears examined showed bovine blood, most of the mosquitos had been found in or around cow-sheds, where they tend to rest. Often 20–200 were found per cow-shed, whereas the average in houses was less than one per 100. Malaria and filariasis are sometimes confined to the inhabitants of a small group of houses in a village. This may be due to the fact that *A. gambiae* does not fly strongly or far, so that little migration from an attractive feeding and resting site takes place. In captivity, 78, 62 and 49 per cent. of females matured their ovaries on the blood of man, cow and deer, respectively. Most of the females of *A. gambiae* resting in cow-sheds at night were unfed, and most of those resting there by day were in the late blood-fed stage or half gravid. Gravid females were commoner in cow-sheds by day than by night; this suggests an early evening exodus. The ratio of nulliparous to parous females was about 9:1. The gonotrophic cycle (the interval between the initial blood-meal and the beginning of egg-laying) occupied about 97 hours in winter and 94 in summer, but it apparently tended to vary according to the host. The peak of activity was reached earlier in the night than is usual in Africa [*cf.* **45** 24]. A similar trend has been noticed in other mosquitos in Mauritius and in *A. gambiae* in other islands, and it is suggested that the rapidly rising relative humidity of the night air in a small island may cause activity to cease. The peak of the biting cycle in the insectary was some 1–2 hours later than that of the general activity cycle. It was confirmed that *A. gambiae* is a minor vector of *W. bancrofti* in Mauritius. The major vector is *Culex pipiens fatigans* Wied., which is not easily deviated from man, as evidenced by the finding that 84 per cent. of the *fatigans* females collected in cow-sheds contained human blood. Only two light oocyst infections have been found in 4,526 dissections of stomachs and salivary glands of *A. gambiae* made since 1952, and in view of its abundance and the present low incidence of malaria, it seems reasonable to regard it as a poor vector in Mauritius.

The period from hatching to adult emergence in *A. gambiae* in Mauritius lasts about seven days in summer and 15 days in winter. *A. funestus* had a life-cycle at least three times as long. It may be this rapid breeding that enables *A. gambiae* to build up its numbers when they are reduced by control measures [*cf.* **43** 6]. The egg stage in waters of known composition lasted significantly longer in winter than in summer. Egg batches per female were larger in summer, for the eggs of both the first and the later gonotrophic cycles. The numbers of eggs per batch varied with the host animal, averaging about 100 with rabbit, 111 with cow and 140 with man. Hatching took place to some extent in water heavily charged with sodium chloride or copper sulphate, but the larvae ceased to develop when the sodium-chloride content rose to 17·5 gm. per litre. Eggs hatched well after being kept on damp filter paper at room temperatures for 10–14 days, but did not hatch when kept on dry filter paper for six days. The number of teeth per maxilla in females of *A. gambiae* in Mauritius ranged from 12 to 16 [*cf.* **41** 115].

Kirk (R.) & Lewis (D. J.). **Studies in Leishmaniasis in the Anglo-Egyptian Sudan. XI.** *Phlebotomus* **in Relation to Leishmaniasis in the Sudan.** —*Trans. R. Soc. trop. Med. Hyg.* **49** no. 3 pp. 229–240, 3 maps, 55 refs. London, 1955.

An outline is given of the history of the discovery that sandflies (*Phlebotomus*) are vectors of visceral and cutaneous leishmaniasis (kala-azar and oriental sore), together with lists of the species known or believed to be vectors of these diseases in different parts of Europe and Asia and of mucocutaneous leishmaniasis in America. Observations on sandflies in relation to visceral and cutaneous leishmaniasis in the Sudan are then reviewed, and the information contained in earlier papers of this series [*R.A.E.*, B **28** 201; **38** 218] is brought up to date by details of two experiments in which sandflies were allowed to feed on cases of post-kala-azar dermal leishmaniasis. These experiments were designed to test the hypothesis that *P. clydei* Sinton might play a part in transmission, although it does not belong to the subgenus *Phlebotomus* [*cf.* **43** 71]. In the first experiment, the volunteer slept under a sandfly net with holes in it, the sandflies inside the net were collected in the morning, and those that had fed were kept until they died or appeared likely to die and were then examined for flagellates in the alimentary canal and head. Five of 71 individuals of *P. orientalis* Parr. were infected, one of them anteriorly, and it is concluded that this species can be regarded as the likely vector of kala-azar in the Sudan. One of 40 individuals of *P. clydei* also became infected, but the infection was not of the anterior type. In the second experiment, unfed females of *P. clydei* and *P. papatasi* (Scop.) collected in nature were applied to skin lesions on the face of the volunteer. These lesions contained abundant leishmania parasites, and it is estimated that the sandflies were 20 times as likely to acquire infection as those taken in the first experiment [*cf.* **43** 71]. Three out of 40 females of *P. papatasi* and one out of 73 of *P. clydei* became infected, the infection in *P. clydei* being apparently anterior. *P. papatasi* can be excluded as a vector of kala-azar in the Sudan on epidemiological grounds. It is not possible to assess the importance of *P. clydei* from the results obtained. Other possible vectors are very briefly discussed [*cf.* **43** 70]. *P. papatasi* is believed on epidemiological grounds to be the principal vector of oriental sore in the northern Sudan.

Symes (C. B.). **Filarial Infections in Mosquitoes in Fiji.**—*Trans. R. Soc. trop. Med. Hyg.* **49** no. 3 pp. 280–282. London, 1955.

In investigations on the vectors of the non-periodic form of *Wuchereria bancrofti* in Fiji, mosquitos caught in the bush or in houses were examined for filarial infection. The percentages in which infections and (in brackets) mature or nearly mature infections were found were 2·8 (0·12) in 828 females of *Aëdes pseudoscutellaris* (Theo.) or *A. polynesiensis* Marks (which were not differentiated), 4·8 (0·34) in 583 of *Culex pipiens fatigans* Wied., 10 (1·3) in 222 of *C. annulirostris* Skuse, 21·6 (1·9) in 314 of *A. fijiensis* Marks, 1·1 (0·28) in 356 of *A. vexans* (Mg.), 15 (0) in 46 of *A. aegypti* (L.), and 6 (0) in 16 of *Mansonia crassipes* (Wulp). The difficulties of identifying *W. bancrofti* in wild-caught mosquitos are discussed, and reasons are given for concluding that most or all of the infections found were of this species. When laboratory-reared mosquitos were fed on infected volunteers with 22–169 microfilariae per 20 cu. mm. blood, mature infections developed in 43 of 194 females of *C. p. fatigans*, 40 of 76 of *A. fijiensis* and 22 of 36 mosquitos of which five were *A. pseudoscutellaris* and others either this species or *A. polynesiensis*. No other species were tested. The data would

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appear to suggest that both *C. p. fatigans* and *A. fijiensis* are effective vectors in Viti Levu and should be taken into consideration in the planning of control schemes.

Cova García (P.) & Suárez (O. M.). **Hallazgo en neumáticos para automóviles y depósitos domésticos de *Haemagogus splendens* Williston, 1896.** [The Finding of *H. splendens* Will. in Motor Tyres and domestic Water Tanks.]—*Bol. Ent. venezol.* **11** (1955) no. 3–4 pp. 141–143, 2 figs. Caracas, 1956. (With a Summary in English.)

Numerous larvae of *Haemagogus splendens* Will. were found developing in discarded motor tyres in a small town in a coffee- and cacao-growing area of Venezuela. It is suggested that the mosquito may be becoming adapted to urban habitats.

Trapido (H.) & Galindo (P.). **The Investigation of a sylvan Yellow Fever Epizootic on the North Coast of Honduras, 1954.**—*Amer. J. trop. Med. Hyg.* **4** no. 4 pp. 665–674, 2 maps, 15 refs. Baltimore, Md., 1955.

Deaths among howler monkeys (*Alouatta*) in July and early August 1954 on the coastal plain of northern Honduras were proved by histopathological examination to have been caused by yellow fever. The area in question has a high but erratic rainfall and a mean temperature that ranges from about 80°F. in mid summer to 70° in December, and the forest is broken and swampy so that conditions are quite unlike those of the rain-forest of mountain slopes in which epizootics occurred in Panama, Costa Rica and Nicaragua during the preceding five years [*cf. R.A.E.*, B **45** 9–10]. Large numbers of mosquitos were collected in the forest canopy near the place where the monkeys had died, and 17,420 of them were identified, of which about 11,000 were pooled alive and frozen for air shipment to Panama and subsequent attempted recovery of virus.

Haemagogus equinus Theo., which can transmit yellow fever in the laboratory [*cf.* **39** 71; **40** 115, etc.] but has not been recorded with certainty as infected in the field [*cf.* **33** 112], was the only species of its genus represented in the collection, of which it comprised rather more than 3 per cent. It is widespread in Central America and has been taken in the Atlantic drainage area of Mexico as far north as the south-western corner of the State of Tamaulipas, which borders Texas on the Gulf Coast. Small numbers of *H. spegazzinii falco* Kumm, Osorno & Boshell, a natural vector in South America [**37** 26–27], were taken on mountain slopes in true tropical rain-forest some 6–12 miles to the south of the place where the monkeys died and also 22 miles to the west of it, but no evidence was found of mortality among monkeys in these places. The authors believe that the north coast of Honduras is at or near the northern limit of the range of this mosquito. Apart from species of *Psorophora* and *Mansonia*, which formed more than 70 per cent. of the 17,420 mosquitos taken in the canopy but which bite chiefly at ground level and are not thought to be involved in the transmission of yellow fever, the commonest species was *Trichoprosopon magnus* (Theo.), which comprised just over 10 per cent. and about the vector ability of which nothing is known. It breeds in a species of *Calathea* that occurs in low swampy forest, whereas yellow fever had previously occurred on high slopes in Central America. *Sabethes chloropterus* (Humb.), which had been present at the sites of recent outbreaks of yellow fever in Central America [*cf.* **41** 26] was present in moderate numbers. No case of yellow fever was recognised in man in the immediate area of the epizootic during or after the deaths in monkeys.

HANSENS (E. J.). **Control of House Flies in Dairy Barns with special Reference to Diazinon.**—*J. econ. Ent.* **49** no. 1 pp. 27–32. 4 refs. Menasha, Wis., 1956.

In continued tests on the control of house-flies [*Musca domestica* L.] in dairy barns in New Jersey in 1955, phosphorus insecticides were compared as sprays to leave toxic deposits and as dry and liquid baits [*cf. R.A.E.*, B **44** 73]. The seven compounds * used were Dow ET-14 (O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate), Dow ET-15 (O-methyl O-2,4,5-trichlorophenyl phosphoramidothioate), Diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate], malathion [O,O-dimethyl S-1,2-di(ethoxycarbonyl)ethyl phosphorodithioate], Am. Cyanamid 4124 [O,O-dimethyl O-2-chloro-4-nitrophenyl phosphorothioate], Chlorthion [O,O-dimethyl O-3-chloro-4-nitrophenyl phosphorothioate] and Bayer L 13/59 [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate]. The first five were tested in both sprays and baits, Chlorthion in sprays only and Bayer L 13/59 in baits only.

There was again considerable variation in the effectiveness of individual insecticides, depending on breeding conditions and in some cases on the material used in barn construction. All insecticides were effective for a shorter time in a barn with a corrugated aluminium roof than in any other. Diazinon was the most effective, both in sprays and baits. Applied at 1 per cent. in wettable-powder suspension, it gave control for 90 and 133 days in two barns sprayed in May, and until the end of the season in those sprayed later. In sprays prepared from an emulsion concentrate, it gave control for 45 and 84 days in two barns in which it was applied at 0·5 per cent. in June and for 108 and 110 days in two in which it was applied at 1 per cent. in May. In one barn sprayed in May 1954, it gave control for more than 14 months. A mixture of Diazinon with butoxypolypropylene glycol (Crag Fly Repellent) was less effective than Diazinon alone. Of the other materials tested as sprays, Dow ET-14 gave control for eight weeks as a 0·5 per cent. wettable-powder suspension but was less effective at the same strength in an emulsion; Am. Cyanamid 4124 gave control for 3–6 weeks at 0·5 and 1 per cent. both in suspensions and emulsions, Chlorthion gave control for seven weeks at 1 per cent. in wettable-powder suspension, Dow ET-15 gave control for 4–5 weeks at 0·5 per cent. in emulsion and 4–7 weeks at 0·5 per cent. in wettable-powder suspension, and malathion, at just over 1 per cent. in either form with sugar, generally gave control for 2–4 weeks. Dow ET-14 and Dow ET-15 apparently killed slowly, and few dead flies were found in the barns treated with them.

As dry baits (1 per cent. on sugar), usually applied at 2 or 4 oz. per 1,000 sq. ft., Diazinon and Bayer L 13/59 gave the best results, and Dow ET-14, Dow ET-15 and Am. Cyanamid 4124 were fairly effective, as was Ortho dry bait (2 per cent. malathion on hominy grits), but 1 per cent. malathion on sugar and another malathion preparation were unsatisfactory. Liquid baits were about equal to dry baits, but had the advantage of some lasting action. Diazinon was slightly better than malathion or Bayer L 13/59, the only other materials tested in liquid baits. Baits failed to control *Stomoxys* [*calcitrans* (L.)], which formed a large proportion of the flies in the barns treated with them from mid-July to September, but the better baits gave satisfactory fly control where *Stomoxys* was not abundant and the barn was reasonably clean. The "plate" method of comparing the effectiveness of baits (exposing them on dishes and counting the flies coming to them or

* The chemical names of these compounds (of which the first two were given by the author) are cited in accordance with the rules already noticed [*R.A.E.*, B **43** 35, note] for the nomenclature of compounds containing one phosphorus atom. It is now proposed to adopt the rules for such compounds in this *Review*.—*Ed.*

dead on the dishes) was found to be unsatisfactory. Nearly all the toxicants were repellent. The use of baits to supplement sprays when the deposit began to fail gave poorer control than additional spraying, but is less costly.

Horn-flies [*Siphona irritans* (L.)] were controlled for two months or more on herds using barns sprayed with 0·5 per cent. Diazinon as an emulsion even though the cattle were in the barns for only 2–3 hours per day. Tests in which house-flies were exposed in gauze-ended cages near the wall of a barn that had been sprayed with Diazinon, on untreated plywood panels that had been left in a treated barn for 24 hours, or close to treated panels showed that flies are killed by the fumigant effect of the vapour and by contact with Diazinon deposited from the vapour on to an untreated surface. On the day of spraying with Diazinon at 1 per cent. in wettable-powder suspension, there was complete mortality of flies exposed to vapour in cages in a treated barn and in an adjacent unsprayed milk room. Six days later, mortality of caged flies was 96 per cent. in the barn and only about 2·4 per cent. in an unsprayed barn 50 ft. away.

Tests on samples of milk from cows housed in barns treated with sprays or baits of Diazinon showed that there was no Diazinon or cholinesterase inhibitor in the milk and that its flavour was not affected.

Micks (D. W.). **Laboratory Rearing of the Puss Caterpillar, with Notes on the Incidence of Parasitism.**—*J. econ. Ent.* **49** no. 1 pp. 37–39, 3 figs., 4 refs. Menasha, Wis., 1956.

Despite the severity of the dermatitis and other reactions caused by contact with larvae of *Megalopyge opercularis* (J. E. Smith), which are sometimes very abundant in Texas [*cf. R.A.E.*, B **11** 4; **12** 26], little is known of the nature of the poison in their spines. In order to investigate the exact nature and mode of action of the toxic principle, it is necessary to have very large numbers of larvae, and a simple method was developed for rearing them in the laboratory. Mature larvae collected near Galveston were put in jars, and fresh leaves of yaupon [*Ilex vomitoria*] were provided daily and dead ones removed at least three times a week. The larvae pupated within about two weeks and the first adults emerged about a month later. The females began to oviposit in about a week, laying batches of 25–120 eggs, and these were transferred to clean jars. When the larvae hatched, they were provided with leaves as before, and they matured in about six weeks at 25°C. [77°F.]. The life-cycle of approximately three months made it possible to rear several generations a year.

Tachinid parasites emerged from or were found in 123 of 624 cocoons spun by larvae that had pupated after being collected in Texas in November and December 1954. Most of these were *Carcelia lagoae* (Tns.) and the others belonged to a species of *Phorocera*, probably *P. claripennis* Macq. Host cocoons contained 1–5 parasites and living fly pupae were found in a few two months after they had been spun. The only other parasite was an Ichneumonid, *Compsocryptus retentor* (Brullé), which emerged from one of the cocoons.

Cochran (D. G.). **The Distribution and Metabolism of DDT injected into the American Cockroach.**—*J. econ. Ent.* **49** no. 1 pp. 43–49, 22 refs. Menasha, Wis., 1956.

Studies are described in which measured doses of DDT were injected in solution into the haemolymph in the thoracic region of adults and last-instar

nymphs of both sexes of the American cockroach (*Periplaneta americana* (L.)) and observations made on its subsequent distribution in the tissues and the sites of metabolism. The metabolites were not identified but are referred to as DDE [1,1-bis(p-chlorophenyl)-2,2-dichloroethylene], which was assumed to constitute the major portion of them. The tissues dissected for examination were classified as fat-body, gonadial tissue (including gonads and accessary glands), Malpighian tubules, alimentary canal, thoracic muscles, brain and nerve cord, and remaining tissues (all parts of the body not examined separately). Acetone rinses of the dissected tissues, designed to remove any DDT present in the adhering haemolymph, were negative. DDT was found in all tissues except the brain and nerve cord, which were completely negative. The largest amounts were in the alimentary canal, thoracic muscles, fat-body and remaining tissues. It is thought that DDT is probably absorbed and distributed by fat in the blood and later lost by the blood fat to fat in other parts of the body. It is also possible that it is mechanically distributed by becoming suspended in the blood as it moves about the body and conceivable that an equilibrium is established between the non-lipoid part of the blood and DDT. Most of the DDT in the alimentary canal was in the fore-gut, but some was in the other parts. Tests of faecal material up to 96 hours after injection were negative.

With respect to storage of DDE or possibly actual metabolism of DDT, it appeared that the fat-body is the most important tissue, with the alimentary canal and remaining tissues also of significance. Total percentage recovery of DDT was neither good nor consistent. When known amounts of DDT and DDE were added to dissected tissues and extracted as soon as possible, DDT was recovered in virtually theoretical amounts from all tissues and DDE was recovered in less than theoretical but satisfactory amounts except from the fat-body and the remaining tissues from which recovery was poor. The finding of large amounts of DDE in these tissues in treated cockroaches, in spite of poor recovery *in vitro* may indicate that they are of much greater importance in metabolism than they appear to be. Importance of the fat-body in metabolism might be correlated with differential susceptibility of the sexes and stages, as the adult females and last-instar nymphs of both sexes have considerably larger fat-bodies than the much more susceptible adult males. Another feature of possible importance was the finding of larger amounts of DDT in the alimentary canal of adult males receiving 15 μg. than in females receiving 35 μg.

Moreland (C. R.) & McLeod (W. S.). **House Fly Egg-measuring Techniques.**—*J. econ. Ent.* **49** no. 1 pp. 49–51, 1 fig., 16 refs. Menasha, Wis., 1956.

Methods used to estimate numbers of eggs of *Musca domestica* L. for mass rearing are all volumetric, but there has so far been little standardisation of technique, and the wide variation in egg counts reported (500–750 per 0·1 ml.) shows the need for it and particularly for standardisation of the consolidation of the eggs. The centrifuge-tube, the graduated pipette and the pit methods were compared in the authors' laboratory at Ottawa. Eggs laid on pads of cellucotton soaked in hot skim milk were transferred to a 15-ml. centrifuge tube containing tap water at room temperature. The tube was shaken to wash the eggs and break up clumps, and floating eggs and surplus water were removed. Water was added and the procedure repeated twice more. With the tube used, 20 counts gave an average of 2,750 eggs per 0·4 ml., with a standard deviation per count of $\pm$ 188 eggs. A disadvantage of this method is that every tube has to be individually calibrated. When the washed eggs were transferred to a 5-ml. measuring pipette graduated in

tenths and having one end covered with bolting silk, 20 counts of 0·3 ml. each gave an average and standard deviation of 2,687 and ± 83 eggs. Consolidation must be standardised to achieve such a degree of accuracy. Exact reproduction of measurement of eggs was always obtained when the screened end of the tube rested on a wet cellulose sponge in free water in a dish. A given volume of eggs always returned to the same mark when drained on the sponge. Another method used was almost to submerge the pipette in water, add the eggs and allow them to settle. However, if agitated after first settling, the eggs almost always resettled to a different mark, though sometimes the latter could be reproduced after further agitation. Syringing clear water into the pipette consolidated the eggs satisfactorily if enough water was used, but the technique was awkward. The pipette method is slow at first but becomes rapid with practice. Eleven counts of eggs in a pit in an aluminium bar gave an average and standard deviation of 1,265 and ± 366 eggs, and the method was not further investigated.

The differences between the errors with the various methods were shown to be significant. However, when flies were reared from eggs measured by the centrifuge and pipette methods, analysis of variance showed no significant difference in the numbers of pupae yielded between days, and the standard deviation for yields of pupae did not differ significantly between methods. In view of this, the centrifuge-tube method is preferred for mass rearing because of ease of manipulation. The graduated pipette is more accurate and might be of value for special research.

Sampson (W. W.). **Insecticides used to control House Fly Larvae.**—*J. econ. Ent.* **49** no. 1 pp. 74–77, 31 refs. Menasha, Wis., 1956.

The control of larvae of *Musca domestica* L. with many chemicals, most of which had previously been tested against them by other workers, was investigated in the field in California in 1952–54. They were applied as sprays in water solutions or emulsions at 225 ml. liquid per sq. ft. to accumulations of organic matter (poultry, cow or rabbit manure, lawn clippings, leaves, garbage piles or cannery or slaughter-house waste) at least 2 ft. square. Endrin, heptachlor, γ BHC (lindane) and parathion gave 100 per cent. kill at 0·125 per cent., Diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate], DDT, dieldrin, phenothiazine and toxaphene at 0·25 per cent., chlordane, malathion and sodium pentachlorophenate at 0·5 per cent., aldrin, copper naphthenate, naphthalene, tetrachlorophenol and thiourea at 1 per cent., DDD (TDE) at 2 per cent. and sodium arsenite at 3 per cent. DNC was erratic, giving complete kill at 0·25 and 3 per cent. but only about 90 per cent. at 0·5 and 2 per cent. Methoxy-DDT (methoxychlor) gave 91 per cent. kill at 4 per cent.

Materials found to be apparently worthless included borax, chloride of lime, various petroleum oils, distillates and thiocyanates, dinitrophenol, pentachlorophenol, p-dichlorobenzene, Aramite [2-chloroethyl 2-(p-tert.-butylphenoxy)-1-methylethyl sulphite], zinc naphthenate, pyrethrum (with or without piperonyl butoxide), allethrin, technical BHC, soap and a synthetic detergent. Penetration of spray is influenced by the moisture content of the pile, the presence of impervious, shielding or deflecting material, and the presence of larval migration channels, through which the insecticide may be canalised to the bottom of the pile. Several light sprayings give better results than one heavy one with piles having a hard surface. The moist but not wet situations in which the larvae normally develop allow of good penetration and dispersion without excessive run-off. Effectiveness was also influenced by the driving-out effect of the chemicals.

Johnson (W. T.), Langford (G. S.) & Lall (B. S.). **Tests with organic Phosphorus Insecticides for Fly Control.**—*J. econ. Ent.* **49** no. 1 pp. 77–80, 2 refs. Menasha, Wis., 1956.

Studies were made in Maryland in 1954 to compare the value of malathion, Diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate], Pirazinon [O,O-diethyl O-2-propyl-4-methyl-6-pyrimidinyl phosphorothioate], Am. Cyanamid 4124 [O,O-dimethyl O-2-chloro-4-nitrophenyl phosphorothioate], Chlorthion [O,O-dimethyl O-3-chloro-4-nitrophenyl phosphorothioate] and Bayer L 13/59 [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate] for the control of house-flies [*Musca domestica* L.] in farm buildings. Sprays containing 0·5 per cent. malathion, Diazinon or Am. Cyanamid 4124 applied to walls and ceilings at a pressure of about 150 lb. to the point of run-off gave good control whether prepared from emulsion concentrates or wettable powders, and with or without the addition of sugar (20 lb. to 100 U.S. gals.). The effect of emulsions lasted slightly longer than that of suspensions. Diazinon gave protection for 30–60 days, and malathion and Am. Cyanamid 4124 for about 20–30 days.

The lasting effect of Diazinon and the lack of marked difference between formulations containing a given insecticide were not, however, confirmed in experiments in which deposits were tested by dipping wooden panels in 1 per cent. suspensions or emulsions of the insecticides with or without 12 per cent. sugar. When flies were exposed to the panels 13 weeks after they had been treated with formulations that did and (in brackets) did not contain sugar, the percentages down after 20 hours were 80 (4), 34 (59) and 89 (14) with malathion, Diazinon and Am. Cyanamid 4124 as emulsions, 96 (6) with a solution of Bayer L 13/59, and 3 (3), 9 (2), 12 (1) and 12 (31) with suspensions of malathion, Chlorthion, Diazinon and Pirazinon. A practical test in which a barn was sprayed with a solution containing 0·8 per cent. Bayer L 13/59 and 6 per cent. sugar gave disappointing results. Flies were practically eliminated for three days, but increased rapidly thereafter.

The six compounds were all effective in laboratory tests as liquid baits in which they were used at 0·25–1 per cent. with 12 per cent. sugar [*cf. R.A.E.*, B **43** 102]. Baits with 1 per cent. toxicant gave 90–100 per cent. kill in a feeding period of two hours. The flies fed readily on most of the baits, and those containing Bayer L 13/59 attracted more than sugar solution alone. Am. Cyanamid 4124 was initially repellent but caused rapid knockdown. Some of its toxicity appeared to be due to vapour. For field tests, liquid baits contained 12 per cent. sugar and 0·4 per cent. toxicant and were applied to concrete floors with a sprinkling can or to stanchion pipes, beams, etc., with a compressed air sprayer, at 2–3 U.S. gals. per dairy barn of 40–50 stalls, and dry baits were composed of insecticide and sugar so that they contained 1 per cent. toxicant and were applied to concrete floors by hand or shaker at 2–3 lb. to a barn of 40–50 stalls. All were effective when used every 3–6 days, but liquid baits were usually more rapid in action, and gave longer protection, particularly if applied to stanchion pipes, etc. This was presumably because of the effect of cleaning operations on baits on the floor, particularly dry ones. Malathion, Chlorthion, Am. Cyanamid 4124, Diazinon and Pirazinon in liquid baits practically eliminated flies from barns for periods averaging 7·5–8·5 days and ranging from about 2 to 15 days. Bayer L 13/59 kept flies under control for 3–5 days. Liquid baits prepared with 0·2 per cent. toxicant and 6 per cent. sugar gave excellent results for 1–2 days but needed to be used daily for effective control. The average periods of protection given by baits with 0·8 per cent. toxicant and 24 per cent. sugar were not much longer than those given by the baits with half these quantities. Liquid baits prepared with 12·5 per cent. sugar and 1 per cent. of the six insecticides and tested after storage for 17 weeks gave much slower

knockdown than fresh baits, but all gave 98 per cent. knockdown or more after a feeding period of 20 hours except Pirazinon, which gave 64 per cent.

Thornton (D. G.) & Davis (J. M.). **A Method of Sampling for the Drop Size of Aerial Spray Deposits.**—*J. econ. Ent.* **49** no. 1 pp. 80–83, 1 ref. Menasha, Wis., 1956.

The following is the authors' summary. A method was devised for sampling drop records in determining the atomization of aerial spray deposits. It requires the selection at random of a small number of mass median diameter determinations and computation of the mean mmd and error of this sample. In turn, each determination involves measuring drops on an area on each of a number of cards placed at regular intervals across the spray swath. Two methods of selecting drops for an mmd determination were used. In one, the constant area method, a single area was marked on each card and all drops within the area were measured. In the other, the variable area method, the size of the area was varied approximately as the cube of the drop diameter, so that large drops were sampled more intensively than small ones. With respect to time required for drop measuring and computation of a mean mmd with a 10 per cent. error, the variable area method proved superior in three out of four flights. Additional comparisons of the two methods will be continued in future studies of the atomization of aerial spray deposits.

McGregor (W. S.) & Bushland (R. C.). **Research on the Use of systemic Insecticides for the Control of Livestock Pests.**—*J. econ. Ent.* **49** no. 1 pp. 86–88, 13 refs. Menasha, Wis., 1956.

Early work on the possibility of using insecticides systemically for the control of pests of livestock is reviewed, with particular reference to preliminary screening tests made with larvae of *Hypoderma lineatum* (Vill.) [*R.A.E.*, B **38** 2; **43** 104] and *Callitroga hominivorax* (Coq.) [**43** 187], and the technique in use for further testing at Kerrville, in southern Texas, is described. Against larvae of *C. hominivorax*, chemicals are first tested by subcutaneous injection into guineapigs, then by oral administration to guineapigs and, if promising in these tests, by oral administration to sheep. Chemicals effective against the larvae on guineapigs are also effective against them in sheep, but only at much higher doses. Bayer L 13/59 [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate] killed larvae in guineapigs at 2·5 mg. per kg., but about 20 mg. per kg. was needed in sheep. Dieldrin, aldrin, γ BHC (lindane), Bayer L 13/59, Diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] and Chlorthion [O,O-dimethyl O-3-chloro-4-nitrophenyl phosphorothioate], which killed larvae of *C. hominivorax* in guineapigs, also killed larvae of *H. lineatum* encysted in the backs of cattle, but were not effective against first-instar larvae [*cf.* **43** 187]. In the Kerrville area, larvae of *H. lineatum* are found in the backs from August to the end of November. Chlorinated-hydrocarbon and phosphorus insecticides administered in the autumn when the first larvae were encysted killed those already in the second and third instars, but more larvae migrated to the backs later in the season and developed normally. Chlorinated hydrocarbons administered in the spring soon after adult activity ceased were ineffective; others were not tried at this time. C. L. Smith observed that dieldrin, aldrin, γ BHC and Diazinon given at doses effective against *Hypoderma* in cattle also killed *Linognathus vituli* (L.) on the animals, and that Diazinon injected into Angora goats at 10 mg. per kg.

killed *Damalinia* (*Bovicola*) *caprae* (Gurlt). Diazinon at the same dosage also killed *Gliricola porcelli* (Schr.) on guineapigs. R. W. Wells found that γ BHC and aldrin administered to cattle at 50 mg. per kg. and dieldrin at 25 mg. had no effect on *Amblyomma americanum* (L.).

Systemic insecticides have also been used in tests against blood-sucking Diptera [**39** 88; **42** 35, 187], but it is concluded that one that is effective against pests but so low in toxicity to mammals that it can be safely used by farmers has not yet been found. Horses and other animals not intended for food may be treated with γ BHC, but the difficulty of injecting subcutaneously large quantities of an oil solution and the small margin of safety limits its use to veterinary surgeons. Phosphorus insecticides have been successfully administered by oral dosing, but no insecticide that can be given by a stockman as a drench or mixed with salt or ground feed is yet known.

Radeleff (R. D.) & Woodard (G. T.). **Toxicological Problems in the Use of systemic Insecticides for Livestock.**—*J. econ. Ent.* **49** no. 1 pp. 89–91. Menasha, Wis., 1956.

Toxicological problems involved in the treatment of animals with systemically active insecticides are reviewed. One arises from the fact that though the degree of inhibition of cholinesterase, which is used as a measure of the toxicity of organic phosphorus compounds, can be readily ascertained, variation in cholinesterase reserves between individuals of a species is wide, and precludes assessment of a degree of damage less than active poisoning unless control samples from the same animals are available. Also, the cholinesterase reserves of cattle and sheep gradually decline when the animals are transferred from pastures to feed lots. If a system such as blood cannot be studied, reliance has to be placed on observation of symptoms and lesions. Even after extensive use has indicated that a treatment is completely safe, some combination of factors may render a particular group of animals susceptible and lead to severe losses. Each kind of animal has to be studied separately before a systemic insecticide can be recommended for use on it. A recommended compound should be safe for as many kinds as possible and effective at about the same dosage in each. A 10:1 margin of dosage safety is desirable.

Subacute or chronic toxicity must be considered when a compound is administered subcutaneously in oil. Complete absorption sometimes takes several months. Much of a compound with a low rate of elimination, administered when the animals were gaining weight, would be stored in the fat and might be released to circulate over the body more rapidly than it was eliminated, when fat deposits were depleted in autumn and winter. A compound could also be changed to a more toxic one while being transported to the fat. It may be that the metabolic pathway used varies with the route of administration or the kind of animal or the individual. Research on the effect on enzymes other than cholinesterase and on intestinal flora are needed before a treatment is recommended for general use. The health hazard involved in the presence of insecticide in the fat or other tissues of food animals or the milk prevents the general use of dieldrin, aldrin or γ BHC (lindane) for injection into farm animals.

A disadvantage of injection is the large volume of fluid needed. Increasing concentration raises toxicity to the animal. Another disadvantage is the impossibility of retrieving the material once it has been administered, as can sometimes be done by washing off insecticide applied to the skin or purging in the case of oral administration. Moreover, both insecticide and solvent or vehicle must be such as not to cause local reactions of the tissues. When

rapid absorption and elimination are desirable, water solutions or suspensions might be used. If the insecticide is required to be present at the injection site for several weeks, care must be taken to ensure its removal at slaughter. An insoluble colouring agent suspended in the injection fluid might be used to mark the site and necessitate trimming, but this trimming might entail greater loss than that due to the presence of the parasite. An insecticide to be administered orally in salt, mineral or other food must be very safe because of the irregular intake and also because it is known that farm boys and dogs often eat some of the food provided for livestock. The effect of systemic insecticides on reproduction and on animals in poor condition and the effect of administering them when operations are being performed need to be studied.

Jones (C. M.) & Richey (D. J.). **Biology of the Black Flies in Jasper County, South Carolina, and some Relationships to a *Leucocytozoon* Disease of Turkeys.**—*J. econ. Ent.* **49** no. 1 pp. 121–123, 6 refs. Menasha, Wis., 1956.

About 5 per cent. of the 75,000 turkeys reared each year in Jasper County (South Carolina) die as a result of infection with *Leucocytozoon smithi*, which is transmitted by Simuliids, the proved vectors in other parts of the United States being *Simulium jenningsi* Mall. and *S. occidentale* Tns. [*cf. R.A.E.*, B **40** 73]. Examination of blood smears from large flocks showed that all the birds were infected. In a survey of the Simuliids of the county in 1954, seven species of *Simulium*, at least one of them undescribed, and *Cnephia pecuarum* (Riley) were taken. *S. slossonae* D. & S., and *S. congareenarum* (D. & S.) were collected from turkeys, *S. jenningsi* or related undescribed species from cattle and all the species from man, though no instance was seen of man being bitten. Except possibly *C. pecuarum*, all the species can complete their life-cycles in 3–4 weeks and have two or more generations a year. The terrain of the areas in which they were found is wooded and rather flat, and their breeding places in the streams occurred where there was a slight change in elevation or where obstructions caused the water to ripple. The rainfall is sporadic, and breeding ceases when streams stop flowing and is resumed after rains. It is thought that the eggs withstand desiccation. *S. slossonae* was only occasionally found in any stage in February and early March, but was breeding in almost all flowing streams from the end of March onwards. Most of the larvae were found in partly shaded sections of streams, attached to long, trailing leaves of a water plant. The highest concentration was 26 larvae per sq. inch of leaf surface and the largest breeding area was about 100 sq. yards. *S. congareenarum* was the most abundant and widespread species in early February, but it began to decrease in abundance early in May. No adults were seen after 15th May. The larvae were attached to aquatic vegetation. *S. decorum* Wlk. was found breeding at three sites, two of which were concrete spillways at artificial lakes and the third a floodgate-type outlet to a 60-acre lake. There were overlapping generations from early February to early May. The remaining species of *Simulium*, which were widespread but never abundant, were not separated, as there was no evidence that they were connected with *Leucocytozoon*.

Females of *S. congareenarum* and *S. slossonae* usually fed on the head and neck of turkeys and occasionally on the wing or body where the skin was exposed owing to loss of feathers. They fed from dawn to dusk, at temperatures ranging from 66 to 102·5°F., in dark cloudy or even slightly rainy weather or in bright sunlight, and in the presence or absence of a slight breeze. Females of *S. slossonae* were collected from a turkey with a heavy

infection of *Leucocytozoon* in its blood and transferred to the laboratory. Most were dead on arrival, and a saline suspension of ten of them was injected intravenously into four healthy turkeys ten weeks old. The birds were killed for tissue-section studies, 3, 6, 10 and 13 days after inoculation, and gametocytes were numerous in smears from the blood and lungs of the last one killed. One female of *S. slossonae* that was still alive five days after the infective meal was allowed to feed on another disease-free turkey ten weeks old. Gametocytes were found in the peripheral blood 16 days later. When turkeys reared under screened conditions in a disease-free area were brought into the infected area and examined daily, gametocytes of *Leucocytozoon* appeared in the blood stream after about 15 days.

Grayson (J. M.), Jarvis jr. (F. E.) & Levitan (M.). **Transmission of Resistance to Chlordane in the German Cockroach.**—*J. econ. Ent.* **49** no. 1 pp. 130–131, 1 graph, 5 refs. Menasha, Wis., 1956.

The inheritance of resistance to chlordane in *Blattella germanica* (L.) was investigated by comparing its toxicity to cockroaches of a chlordane-resistant strain (R) and a normally susceptible one (S) and to the F_1 offspring of the cross between R females and S males (designated X), those of the reciprocal cross (Y) and those of the back-crosses between Y females and S males (A) and between Y females and R males (B). The toxicity tests were made by dipping adult cockroaches in acetone-water suspensions of chlordane and then keeping them with food and water and counting the dead ones after three, six and ten days. Moribund cockroaches (unable to crawl) were counted as dead. In the case of the males, the ratios of the LD50's and (in brackets) LD90's to those for the strain S were 27·1 (12·9) for X, 32·4 (10·9) for Y, 10·6 (16·9) for A, 23·9 (22·1) for B and 84·1 (78·1) for R. In the case of females they were 30·2 (21·8) for X, 24·1 (18·6) for Y, 17·1 (12·3) for A, 23·9 (81·3) for B and 303·4 (251·8) for R. The relations between concentration and mortality are also given in the form of log-probit regression lines for the parent strains (S and R) and reciprocal crosses (X and Y). Females are more resistant than males, and the lines are not identical in slope, but those for X and Y fall between those for S and R except that the line for R males crosses those for X females, Y females and Y males at successively lower mortality levels. R males are considerably more resistant than X or Y males at both the LD50 and LD90 levels. The fact that Y males are more resistant than S males and must have inherited their resistance from the male parent indicates autosomal transmission of the factors for resistance. Furthermore, autosomal inheritance demands that the results of the reciprocal crosses be identical. The fiducial limits of the regression lines for the X and Y females overlap for their entire length and those for the males cross between probits 5·2 and 6·6. This would indicate that the two populations of males and females are similar even though they may not be identical. Apparently little or no dominance is involved in the activity of the autosomal factors. There was no evidence to indicate the influence of any cytoplasmic or sex-linked factors.

Neel (W. W.). **Tests with self-treating Devices for the Control of Lice on Cattle in Mississippi.**—*J. econ. Ent.* **49** no. 1 pp. 138–140, 3 refs. Menasha, Wis., 1956.

During the winter of 1954–55, cable-type back-rubbers [*R.A.E.*, B **43** 117–118] covered with burlap impregnated with 5 per cent. chlordane in fuel oil or motor oil completely controlled sucking lice (*Solenopotes capillatus* (End.) and *Linognathus vituli* (L.)) on beef cattle confined in groups of

ten on small feed lots (300 × 100 ft.) in Mississippi. The burlap was wrapped round the lower part of the centre pole as well as round the two cables so as to provide an additional rubbing surface. Toxaphene at 5 per cent. gave effective control under the same conditions on the only group of animals on which it was tried, but it needs to be tested further. On large range lots (10–200 acres), back-rubbers impregnated with 5 per cent. toxaphene or a combination of 5 per cent. toxaphene and 0·3 per cent. γ BHC (lindane) in fuel oil, and installed at the rate of about one per 50 animals, did not control the lice.

Raun (E. S.) & Ahrens (R. H.). **A Field Test of Malathion to control Sarcoptic Mange of Hogs.**—*J. econ. Ent.* **49** no. 1 p. 140. Menasha, Wis., 1956.

In preliminary toxicity tests in Iowa in 1955, pigs thoroughly wetted with a spray containing 0·5, 1 or 2 per cent. malathion from an emulsifiable concentrate with an additional wetting agent showed no skin irritation or signs of poisoning during the two weeks after treatment. Pigs that were severely infested with *Sarcoptes suis* Gerl. were therefore sprayed once with the 0·5 or 1 per cent. concentrations under a pressure of 50 lb. Bedding and walls were sprayed at the same time. Both concentrations eliminated the mangy condition in 19 days, whereas the condition of control animals was unchanged after this time and mites were still present on them.

Kusov (V. N.). **Duration of Effectiveness of BHC Dust as Acaricide in Wall Cracks.** [*In Russian.*]—*Veterinariya* **33** no. 1 pp. 70–72. Moscow, 1956.

Investigations in Kazakhstan showed that a 12 per cent. BHC dust that had been blown into the cracks between the stones of the walls of an enclosure for sheep in December 1951 retained its effectiveness against *Ornithodoros lahorensis* Neum. for at least 2½ years. Adults and larvae kept in test tubes with 1–2 gm. of dust removed from the cracks in December 1952 and May 1954 were all killed in 1–6 days, and all examples of the tick and of other arthropods found when parts of the wall were pulled down in May 1953 and May 1954 were dead.

Levinskiĭ (M. S.). **On the Toxicity of BHC applied as Acaricide to Cattle.** [*In Russian.*]—*Veterinariya* **33** no. 1 pp. 72–75. Moscow, 1956.

Two experiments were carried out during 1953–54 to evaluate the possible risks of using emulsified solutions of BHC in dips for cattle. Several hundred cattle of various ages, including calves, were used in each experiment and were immersed 12 times at intervals of ten days in a dip containing 0·25 per cent. BHC in the first, and eight times at fortnightly intervals in one containing 0·4 per cent. BHC in the second. All dips contained 0·04 per cent. soap as a stabiliser, and the immersion period was 30–40 seconds. Each dipping was followed by a slight and transitory reduction in milk yield and some restlessness, especially in the younger cattle, but no evidence of any adverse effects of the BHC was obtained in either experiment by studies of the blood and urine of some of the treated animals or by histological examination of the organs of a few of them. Calves suckled by the treated cows were not poisoned, and the organs of guineapigs and mice that were fed for three months on the milk of cows treated in the first experiment appeared normal at autopsy. Cream from their milk had no unpleasant odour.

Tests in which house-flies (*Musca domestica* L.) were fed on butter containing known amounts of BHC showed that a concentration of 1 part per million would kill five out of ten in 24 hours, but there was no evidence of poisoning in flies fed on milk obtained from cows 12 hours after each of the treatments in the second experiment or on butter made from milk obtained at regular intervals between the treatments. Attempts to detect BHC in the butter by extracting it with chloroform were also unsuccessful.

Palimpsestov (M. A.). **On the Diagnosis of Sarcoptic Mange.** [*In Russian.*]—*Veterinariya* **33** no. 2 pp. 67–70, 7 figs. Moscow, 1956.

The author describes morphological characters by which he has found it possible to differentiate mites of the genus *Sarcoptes* (*Acarus*) that infest various animals and so to ascertain whether a given case of sarcoptic mange is caused by the mite that normally infests the animal or by mites transferred to it from another species of host. The mites concerned (which are referred to by him as subspecies of *Acarus siro* L. [on the view that this is the correct name for *S. scabici* (Deg.)]), and the animals on which they normally occur, are *S. caballi* Oudm. (*equi* Gerl.) on horses, *S. suis* Gerl. on pigs, *S. dromedarii* Gerv. (*cameli* Mégn.) on camels, *S. caprae* Fürst. on goats, *S. vulpis* Fürst. on foxes and wolves, *S. canis* Gerl. on dogs, and *S. cuniculi* Neum. on rabbits. He finds that *S. vulpis* is easily distinguishable from *S. canis*, with which it has sometimes been considered synonymous, but concludes that the mites of wolves and foxes are identical since they could not be distinguished morphologically and mites from foxes readily establish themselves when transferred to wolves.

Soboleva (R. G.). **Tabanids as Ectoparasites of domestic Animals.** [*In Russian.*]—*Veterinariya* **33** no. 4 pp. 71–77, 3 figs. Moscow, 1956.

The results are given of investigations carried out in 1952–54 in the provinces of Moscow and Astrakhan on the importance of Tabanids as pests of cattle. Eight species belonging to three genera were found on cattle in Astrakhan and 20 species of four genera in Moscow, but members of the genus *Tabanus* were predominant, representing 80 per cent. or more of the total in both provinces. The seasonal period of Tabanid activity was from June to the end of August, and the females attacked the animals from 6–7 a.m. to 8–9 p.m., but did so in greatest numbers from 10–11 a.m. to 4–5 p.m. in Moscow and in the morning (8–10 a.m.) and late afternoon (4–9 p.m.) in Astrakhan. Their activity was affected by temperature, the low thresholds being about 15°C. [59°F.] for *Haematopota* (*Chrysozona*) and 20°C. [68°F.] for *Tabanus* in Moscow and 20°C. for all Tabanids in Astrakhan, with optima of 29–34°C. [84·2–93·2°F.] in the former province and 37°C. [98·6°F.] in the latter. Activity was reduced and inhibited by winds of velocities of 8–11 and 12·5–20 miles an hour, respectively. Though darker animals attracted a greater number of flies, it is thought that smell also plays a part in the finding of hosts since animals treated with repellents were not attacked for 2–3 hours or more.

The average amounts of blood taken at a single feeding by individual females of *T. bovinus* L., *T. bromius* L., *T. rusticus* L. and *H.* (*C.*) *pluvialis* (L.) were 200, 100, 100 and 40 mg., respectively. In one of two experiments designed to ascertain the injury suffered by the cattle, three young bulls were exposed to attack for two hours on three successive days when Tabanids were so numerous that 300–450 were attacking an animal in 15 minutes. Subsequent tests of their blood showed a considerable decrease of haemoglobin and erythrocytes as well as an increase of leucocytes. At the same

time the animals were very restless, and showed evidence of extreme sensitivity of the skin and irritation of the injured parts. A normal condition of the blood was restored only after 8–10 days. In the second experiment, an emulsion prepared from the salivary glands of Tabanids and estimated to contain about as much saliva as would be introduced into the animals by bites under natural conditions was injected into seven young bulls. The results of subsequent blood tests are described in much greater detail than those of the first experiment, but indicated a reaction that was in the main similar. One of the bulls died three hours after the injection and autopsy showed inflammation of all the tissues, effusion of blood into the brain and alimentary canal, and necrosis of the kidneys.

Mihályi (F.) & Zoltai (N.). **Contributions to the Occurrence of *Culex pipiens molestus* in Hungary.**—*Acta zool.* **2** fasc. 1–3 pp. 263–268, 7 refs. Budapest, 1956. (With a Summary in Russian.)

The authors cite *Culex pipiens molestus* Forsk. as a subspecies of *C. pipiens* L., in accordance with the terminology of Monchadskiĭ [*R.A.E.*, B **40** 120; *cf.* also **40** 63, etc.], but consider that it would be better to regard it as an ecological race, since it is characterised less by morphological criteria than by its ecology and behaviour, notably its tendency to attack man and its autogeny, stenogamy and homodynamy. The only evidence of its occurrence in Hungary prior to 1950 was provided by Vincent's rearing experiments with *pipiens* mosquitos collected near Lake Balaton [**22** 61], which indicated that they included *pipiens-molestus* hybrids, but the authors were occasionally attacked by mosquitos of this complex near Lake Balaton in 1950–51 and have investigated three cases of mosquito nuisance, undoubtedly due to *molestus*, in other parts of Hungary.

One of these cases occurred in August 1950 in a house on the outskirts of Budapest and was brought to an end when a tank in the garden, in which the larvae were numerous, was treated with oil. The pattern of the abdomen of the females was characteristic of *molestus*. A case of more extensive infestation was observed in a textile bleaching factory in Budapest, where workers suffered mosquito attack throughout the winter. Inspections in March 1950 and in February 1954 showed that breeding was taking place in a large, disused, underground drain, where the water had a pH of 7. Rearing experiments with mosquitos collected at this factory showed that they were autogenous, stenogamous and homodynamic, and adults and larvae had morphological characters of *molestus*. Control was achieved by pumping the water from the drain and spraying the walls and cover with DDT. The walls of the affected part of the workshop were also sprayed. The third case occurred over 900 ft. below ground level in a coal mine in northern Hungary, where the mosquitos were breeding in the tepid water of puddles in several galleries. The larvae had the morphological characters of *molestus*. Control was achieved by spraying with DDT in emulsified solution to give a deposit of 1 gm. DDT per sq. m. on the walls of the galleries and a concentration of 1 part per million in the breeding water.

Dimond (J. B.), Lea (A. O.), Brooks (R. F.) & DeLong (D. M.). **A preliminary Note on some nutritional Requirements for Reproduction in Female *Aedes aegypti*.**—*Ohio J. Sci.* **55** no. 4 pp. 209–211, 4 refs. Columbus, Ohio, 1955.

As a high rate of oviposition had been obtained in females of *Aëdes aegypti* (L.) fed on a mixture of milk and honey (9:1) [*R.A.E.*, B **45** 26–27], an attempt was made to find other proteinaceous materials that would stimulate

egg production. Those tried successfully included human serum albumin, human gamma-globulin, haemoglobin, egg albumin, pepsin, lipase, trypsin, proteose-peptone, and the enzymatic hydrolysates of lactalbumin, casein, soybean meal, and yeast. Eggs were also obtained from females of *Anopheles quadrimaculatus* Say fed on skimmed milk, egg albumin and proteose-peptone, but no further work was done with this species. In view of the success with the various proteins, and particularly the protein hydrolysates, females of *Aëdes aegypti* were fed on mixtures of amino-acids, in the hope of determining the basic nutritional needs for reproduction. It was noted that 18 acids were present in fairly large amounts in most of the proteins that had supported egg production. Solutions of these in the proportions in which they are reported to be present in blood and in casein, given daily in honey water to 500 newly emerged females of *A. aegypti* on cotton pads, resulted in the production of 2,600 and 1,600 eggs, respectively, in nine days. These were the most productive of the mixtures of the 18 acids that were tested. A mixture of 13 of the acids yielded 2,000 eggs, but a mixture of ten of them only 29. No eggs were laid when various media were given, each consisting of three or four acids including isoleucine, tryptophane or both. The former of these acids had previously been shown to be important and the latter indispensable. Honey was originally used as an attractant, but a mixture of levulose and dextrose (5 gm. of each in 100 ml. medium) proved to be a satisfactory substitute, and its subsequent use showed that the honey had not been contributing necessary factors. It appeared that the addition of a commercially available salt mixture to the amino-acid mixtures at 0·15 gm. per 100 ml. medium slightly increased egg production.

Gilbert (I. H.) & Gouck (H. K.). **Evaluation of Repellents against Mosquitoes in Panama.**—*Florida Ent.* **38** no. 4 pp. 153–163, 5 refs. Gainesville, Fla., 1955.

The following is largely based on the authors' summary. Field tests with repellents were carried out in the Panama Canal Zone in February 1953 against mixed populations of mosquitos, of which the species taken (with the number of each in brackets) in five representative collections were *Mansonia titillans* (Wlk.) (361), *M. indubitans* D. & S. (6), *M. fasciolata* (Lynch Arrib.) (2), *M. nigricans* (Coq.) (39), *Anopheles albimanus* Wied. (9) and *A. strodei* Root (1). Tests were made with 16 individual repellents and seven mixtures for application to the skin, and with eight individual repellents and six mixtures for application to clothing. Repellents applied to the skin of the arm or leg were compared directly with another on the opposite limb. Effectiveness as compared with a standard was preferred to actual protection time as an index of performance, as the protection time varies greatly between different hosts and different populations of mosquitos.

Of the 16 individual repellents tested on skin, none differed markedly in effectiveness from 2-ethyl-1,3-hexanediol. The seven that appeared slightly more effective were N,N-diethyl-m-toluamide, o-ethoxy-N,N-diethylbenzamide, 1-(o-methoxyphenyl)-3-buten-1-ol, α-tert.-butylpiperonyl alcohol and the amyl, allyl, and propyl esters of mandelic acid. There were no marked differences between any of the mixtures tested on skin and the standard 6:2:2 mixture of dimethyl phthalate, 2-ethyl-1,3-hexanediol and Indalone, except for two lotions. These contained 40 per cent. repellent, and were about half as effective as the other mixtures when tested at equal volume. There was no evidence of synergistic action between o-ethoxy-N,N-diethylbenzamide and 2-ethyl-1,3-hexanediol or between 2-ethyl-1,3-hexanediol, dimethyl phthalate and dimethyl carbate in a mixture. The addition of ethyl α-cyano-2-furanacrylate slightly increased the effectiveness of dimethyl

phthalate and two mixtures. In the 24 tests (out of 600) in which biting by *A. albimanus* as well as *Mansonia* was recorded, the protection times were about the same against both species.

The three most effective individual repellents for application to the clothing were the amyl ester of mandelic acid, o-ethoxy-N,N-diethylbenzamide and the 2-(2-(2-butoxyethoxy)ethoxy)-ethyl ester of senecioic acid. A mixture containing undecenoic (undecylenic) acid, N-butylacetanilide, N-butyl-4-cyclohexene-1,2-dicarboximide and Tween 80 appeared slightly better than the other mixtures.

Addison (C. C.) & Furmidge (C. G. L.). **Physico-chemical Studies on the Application of Insecticides to Sheep Fleece. VIII. Reactions between natural Fleece and Anionic Wetting Agents.**—*J. Sci. Fd Agric.* **7** no. 8 pp. 552–555, 6 graphs, 10 refs. London, 1956. **IX. The Uptake of Oil Phase from Anionic Emulsion by natural Fleece.**—*T. c.* pp. 556–560, 4 graphs, 1 ref.

In previous papers of this series [*R.A.E.*, B **41** 129; **42** 129, 183; **43** 17; **44** 134], the chemical reactions and consequent physical changes that take place in systems involving fleece, emulsion and cationic wetting agent were fully explored, and physico-chemical principles that control the take-up of emulsion by fleece were defined. It was not found necessary to study anionic wetting agents in the same detail; the work described in the present papers, of which the following is based on the authors' synopses, was carried out to compare anionic with cationic systems and to provide data that might help to explain the variable results obtained in the field use of anionic wetting agents. The first paper is concerned with variations in the interfacial activity of aqueous solutions of anionic wetting agents that occur on addition of natural fleece, and the influence of concentration, chain length and positive ion of the anionic compound and the duration of immersion of the fleece. Differences between anionic and cationic systems are attributed mainly to the greater solubility in the former of the long-chain complex C^+A^- formed by reaction between the soluble constituents of suint and the wetting agent. In the second paper, the stability of anionic emulsions in the absence and presence of fleece is compared with that of cationic emulsions [*cf.* **44** 134]. The quantities of oil phase removed by fleece from anionic emulsions under various conditions are measured. Anionic wetting agents are attractive for the formulation of emulsion dips in that the uptake of oil phase on fleece samples added successively is regular and of suitable magnitude, and is largely independent of the positive ion, chain length and concentration of the wetting agent. They suffer, however, from the serious disadvantage that the uptake of oil phase varies with duration of immersion, which is likely to render difficult the control of insecticide deposits.

Papers noticed by Title only.

Forgash (A. J.). **Differences in Arsenic Tolerance among the Sexes and various Stages of the American Cockroach** [*Periplaneta americana* (L.)]. —*J. econ. Ent.* **49** no. 1 pp. 39–43, 2 graphs, 7 refs. Menasha, Wis., 1956. [See *R.A.E.*, A **45** 95.]

Acree jr. (F.) & Babers (F. H.). **Contaminants in Radioactive Allethrin determined by Paper Chromatography.**—*J. econ. Ent.* **49** no. 1 p. 135, 5 refs. Menasha, Wis., 1956.

Davidson (G.). **Further Studies of the basic Factors concerned in the Transmission of Malaria.**—*Trans. R. Soc. trop. Med. Hyg.* **49** no. 4 pp. 339–350, 9 refs. London, 1955.

Part of the following is the author's summary. As a sequel to epidemiological studies of malaria in a low-lying coastal region of Tanganyika in 1952 [*R.A.E.*, B **43** 62], similar observations were carried out at an altitude of 3,500 ft. in Uganda in 1953. Malaria was holoendemic [*cf.* also **44** 191], and the inoculation rate in infants, derived from parasite indices, was estimated at about one infection every two months. The densities of the vector mosquitos, *Anopheles gambiae* Giles and *A. funestus* Giles, were comparatively low, but their infection rates were high. The estimated inoculation rate from entomological data was of the order of one infection every three days. Daily survival rates of the females, estimated by comparison of immediate and delayed sporozoite rates [**43** 62] and by measurement of the ampulla of the oviduct [**44** 177–178], were 97 and 95 per cent. respectively for *A. gambiae* and 93 and 94 per cent. for *A. funestus*. The sporozoite method of estimation is preferred, as the ampulla method, though much more direct and rapid, depends for accuracy on the renewal of the mosquito population at a steady rate. An analysis on numerical lines of the transmission of malaria in the district under study was made, and the implications of the findings in relation to control by insecticides are discussed.

Taufflieb (R.). **Une campagne de lutte contre** *Simulium damnosum* **au Mayo Kebbi.**—*Bull. Soc. Path. exot.* **48** no. 4 pp. 564–576, 1 map, 7 refs. Paris, 1955.

It was established in June 1950 that blindness around the Gauthiot falls, on the Mayo Kebbi above Léré in French Equatorial Africa, where it was so prevalent as to cause whole villages to be evacuated, was due to *Onchocerca* [*volvulus*], and adults of *Simulium damnosum* Theo. were collected at the falls. The author found in 1954 that *S. damnosum* was the local vector and that, during the dry season, it bred only in the Mayo Kebbi for a distance of 35 miles between Tessoko and the mouth of the Mayo Ligam. This was the only stretch where the current was fast enough and marginal vegetation offered suitable resting places for the adults. No other breeding places were found in detailed investigations in January 1955 in preparation for a control campaign, and the average hourly biting rates between 19th January and 13th February at five places along the stretch varied from 8 and 33 at the ends to more than 400 in the central part near the falls. The prevalence of the adults in the central part is attributed to the relatively abundant shrubby evergreen vegetation there, as larvae and pupae were more abundant at the ends.

The campaign was carried out in the dry season from 15th February to the end of March. BHC was used against both adults and immature stages. Against the adults, it was applied from helicopters for a distance of 500 ft. on each side of the river in the form of a mixture of 12·5 parts of a product containing 150 gm. γ BHC per litre and 100 parts gas oil, dispersed as a fog. The theoretical rate of application was 1 mg. γ BHC per sq. metre. The 35-mile stretch was divided into three sections, any one of which could be treated in a day. The number of bites received hourly fell after the first treatment from 33 to 23 in the upstream section, from 400 to 8 in the central one, and from 38 to 0 in the lowest. In view of this the succession of section treatments was so arranged that the two upstream sections were treated 12 times in all and the lowest six. The last adult of *S. damnosum*

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was taken on 24th February, when the section in which it was found had received three treatments. The treatments did not seem to have any considerable effect on *Glossina tachinoides* Westw.

Against the larvae, an emulsion concentrate containing 150 gm. γ BHC per litre was used. It was dispensed at three places (irregularly spaced because of difficulty of access) and six applications at weekly intervals were made at all of them. The duration of each application was about half an hour, to obtain a constant concentration of BHC in the water for this period. At the upstream end of the stretch, 1,800 gm. γ BHC was applied in a mixture of 12 litres concentrate and 30 litres water with the addition of 6 litres clay to increase effectiveness [*cf. R.A.E.*, B **42** 101]. This was to treat 15 miles of river. At each of the other two points of application, half the amount of γ BHC was applied in a 6:6:30 mixture of concentrate, clay or laterite and water, to treat ten miles. As a result of decreasing flow as the dry season advanced, the actual concentrations of γ BHC in the treated water obtained by the successive applications increased from 0·7 to 5·5 parts per million at the first point and from 0·35 to 2·7 p.p.m. at the other two. The results were extremely satisfactory. Simuliid larvae disappeared completely after the first treatment, and pupae found subsequently did not give rise to adults. No toxic action was observed on stock drinking the river water. Mortality among fish was heavy, and the cooperation of a hydrobiologist in planning campaigns is advised, so that the dosage and season can be chosen to do the least possible harm to fish.

Braithwaite (D. P.) & Hemsted (W. R. T.). **The Exhaustion of Cattle Spray-race Fluid.**—*E. Afr. agric. J.* **22** no. 2 pp. 88–91, 2 graphs. Nairobi, 1956.

The following is the authors' summary. A study has been made of the loss of strength of insecticidal emulsions (particularly toxaphene miscible oil preparations) during the spraying of cattle when the fluid is continuously recirculated. It is shown that, in spite of a low preferential-removal rate of insecticide, the total effect is such that serious loss of strength will occur in normal operations, unless replenishment of active material is made during the course of spraying.

Steinhaus (E. A.) & Smith (R. F.). Ed. **Annual Review of Entomology. Volume 2.**—9 × 6 ins., viii + 407 pp., illus., many refs. Palo Alto, Cal., Annual Reviews, Inc., 1957.

The reviews in this second volume of a series [*cf. R.A.E.*, B **45** 27], all of which are noticed elsewhere [A **45** 137–138], include: **The Physiology of Insect Cuticle,** by V. B. Wigglesworth (pp. 37–54, 75 refs.); **Cytogenetics and Systematic Entomology,** by M. J. D. White (pp. 71–90, 86 refs.); **Recent Advances in Veterinary Entomology,** by A. W. Lindquist & E. F. Knipling (pp. 181–202, 145 refs.); **Transmission of Disease Agents by Phlebotomine Sand Flies,** by S. Adler & O. Theodor (pp. 203–226, 1 fig., 104 refs.), which is a survey and discussion of evidence of the relations of species of *Phlebotomus* to the transmission of visceral, cutaneous and mucocutaneous leishmaniasis, *Bartonella bacilliformis* and sandfly fever, with a note on the reaction to their bites known in Israel as harara [*cf.* B **24** 37]; **Genetics of Insect Resistance to Chemicals,** by J. F. Crow (pp. 227–246, 1 fig., 120 refs.); **The Mode of Action of Insecticides exclusive of organic Phosphorus Compounds,** by P. A. Dahm (pp. 247–260, 68 refs.), which deals chiefly with matter published since the earlier review by Kearns [B **45** 27];

Chemistry and Mode of Action of Organophosphorus Insecticides, by E. Y. Spencer & R. D. O'Brien (pp. 261–278, 103 refs.); and **Aerial Application of Insecticides,** by F. E. Weick & G. A. Roth (pp. 297–318, 65 refs.), who discuss the types of aeroplanes suitable for applying sprays and dusts against field-crop pests, the equipment necessary, and the effects of various factors on insecticide distribution.

Busvine (J. R.) & Khan (N. H.). **Inheritance of BHC-resistance in the Housefly.**—*Trans. R. Soc. trop. Med. Hyg.* **49** no. 5 pp. 455–459, 1 graph, 3 refs. London, 1955.

Resistance in house-flies (*Musca domestica* L.) to a group of chlorinated hydrocarbons that includes γ BHC is distinct from DDT tolerance and appears to be more homogeneous [*R.A.E.*, B **44** 111–112]. A preliminary investigation on its mode of inheritance is described. The flies used belonged to a resistant strain (R) of *M. d. domestica* originating from Uruguay and further selected for resistance to γ BHC and a normal strain (N) reared in the laboratory for many years. Single-pair matings were made between R males and N females and R females and N males, and parts of some F_1 families were inbred to produce an F_2 generation. Distribution of resistance within a group was assessed by exposing samples to various concentrations of γ BHC by topical application. The results for males and females of the R and N colonies and of families of progeny of cross-matings in the F_1 and F_2 generations are shown in tables. The median lethal concentration for R flies was about 100 times that for N flies. N flies were more homogeneous than R flies in distribution of susceptibility. Comparatively high mortality in the resistant colony at the lower concentrations indicated that there were some partly susceptible individuals in it. However, there did not appear to be any striking differences in the progeny of various pairs in the crossing experiments, such as might be expected if resistant populations were not homogeneous. Results were generally similar for males and females and for the reciprocal crosses, both in the F_1 and F_2 generations. The F_1 generation was intermediate in resistance between the parents, and its range of variation was rather less. Resistance in the F_2 generation was still intermediate, but lower than in the F_1. According to K. Mather (in Biometrical Genetics, 1949), crossing of types differentiated by multiple allelomorphs results in an intermediate F_1 generation with narrow variation, followed by wide variation in F_2, spanning the gap from one parent to the other. It is concluded that the results of the experiments described are generally consistent with this situation, except for the lower resistance observed in F_2, in which no individuals reached the high levels of the resistant parents.

Hadaway (A. B.). **Cumulative Effect of sub-lethal Doses of Insecticides on Houseflies.**—*Nature* **178** no. 4525 pp. 149–150, 5 refs. London, 1956.

The cumulative effect of repeated sublethal doses of γ BHC, DDT, dieldrin and Diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] on female house-flies [*Musca domestica* L.] was studied by applying small measured doses in kerosene solution topically to the dorsal thorax. In the first series of experiments, two equal doses of each insecticide were applied with no interval and with an interval of 48 hours between them and of γ BHC and DDT also with an interval of 24 hours. The two doses of DDT, dieldrin and Diazinon were fully cumulative, but

when 24 or 48 hours elapsed between the applications of γ BHC, about half the first dose seemed to have been rendered ineffective by the time the second was applied. When smaller amounts (20–25 per cent. of the LD50's for comparable flies) were applied daily for six days, the cumulative mortality percentages were 1 for γ BHC, 20 for DDT, 42 for dieldrin and 60 for Diazinon, and the LD50's of γ BHC and DDT for survivors, 24 hours after the sixth application, were found to be 0·075 and 0·15 μg. per fly compared with 0·094 and 0·39 μg. for similar untreated flies. The daily doses were not fully cumulative even in the case of Diazinon, for which the degree of tolerance was lowest, and it was evident that γ BHC had little cumulative effect, since the six doses caused negligible kill and the LD50 for the survivors was almost as great as that for untreated flies. It is concluded that the results of these experiments appear to substantiate biologically the biochemical findings that susceptible, as well as DDT-resistant, flies can detoxify DDT [*R.A.E.*, B **40** 56] and that susceptible flies can rapidly metabolise γ BHC [**43** 187–188].

Smith (C. E. G.). **A Virus resembling Russian Spring-Summer Encephalitis Virus from an Ixodid Tick in Malaya.**—*Nature* **178** no. 4533 pp. 581–582, 7 refs. London, 1956.

A virus (TP21) serologically resembling that of Russian spring-summer encephalitis was isolated from a pool of 25 adults of *Ixodes granulatus* Supino from two forest rats (*Rattus* spp.) caught near Kuala Lumpur, and sera from two rats of a third species had neutralising antibodies that indicated natural infection with it. *I. granulatus*, which is common and widespread on small tree-living and ground mammals in Malaya, has not yet been recorded biting man there, but it has a wide host-range, and may perhaps transmit a human disease caused by TP21. It is thought that infections with this virus may be common and probably often symptomless in forest rats. Intracerebral inoculation of ground tick material caused paralysis in day-old suckling mice on the fifth day, and passage of bacteriologically sterile brain material from the mice caused paralysis in adult mice on the fifth day and in sucklings on the third day.

Wright (R. H.). **Physical Basis of Insect Repellency.**—*Nature* **178** no. 4534 p. 638, 1 fig., 3 refs. London, 1956.

Evidence has recently accumulated that the odours of substances may be correlated with the low-frequency, fundamental vibrations of their molecules. The absorption of some typical insect repellents in the far infra-red part of the spectrum was therefore examined to determine whether there was a relation between their vibrational mode and repellency. Six commercial repellents (dimethyl phthalate, Indalone, 2-ethyl-1,3-hexanediol, benzyl benzoate, n-propyl-N,N-diethyl succinamate and butoxy propylene glycol) and 14 substances rated as repellent in tests against *Aëdes aegypti* (L.) at the Orlando Laboratory [*cf. R.A.E.*, B **42** 184] were compared with 20 rated as non-repellent in these tests. Infra-red absorption curves were recorded in the region from 700 to 400 cm.$^{-1}$. The curves of the six commercial repellents are shown in a figure. Of the 20 repellent substances, 13 had peaks between 449 and 471 cm.$^{-1}$, three of the others showed strong continuous absorption in this region, and three had nearby broad bands that overlapped it. The non-repellent substances, with few exceptions, showed very little absorption in the neighbourhood of 460 cm.$^{-1}$. The only marked exception in the repellent group was dimethyl phthalate, which had no

absorption peak near 460 cm.$^{-1}$. However, it is one of the few members of the repellent group that has a structure symmetrical enough for certain vibrational modes to be inactive in the infra-red. It is concluded that the physical basis of mosquito repellency is a molecular vibrational mode that can give rise to infra-red absorption or Raman scattering near 460 cm.$^{-1}$ (or 21·7 μ). It is not known whether other kinds of insects are repelled by molecules showing this or some other characteristic frequency.

Jewell (G. R.). **Marking of Tsetse Flies for their Detection at Night.**—*Nature* **178** no. 4536 p. 750, 2 refs. London, 1956.

It would be an advantage in field-work on *Glossina* to be able to detect the resting flies at night. Luminous paint of the type that shines without excitation by ultra-violet radiation was poisonous to the flies and gave too feeble a glow to be useful, but flies marked with a paint formed by mixing B.T.H. "Dayglo" powders (silica-based organic dyes in ethyl cellulose) with a binder and solvent shone brilliantly at 15 ft. in the beam of an ultra-violet lamp worked by 230 volts a.c. and could be located up to a distance of 20 ft. The paint was applied with a sharpened match-stick to the centre of the thorax. The ultra-violet light did not appear unduly to disturb *Glossina morsitans* Westw. A source of ultra-violet radiation has been developed that can be worked from a six-volt battery.

Nelson (W. A.). **Mortality in the Sheep Ked, *Melophagus ovinus* (L.), caused by *Trypanosoma melophagium* Flu.**—*Nature* **178** no. 4536 p. 750, 2 refs. London, 1956.

Though the crithidial stage of *Trypanosoma melophagium* is a normal inhabitant of the midgut of the sheep ked, *Melophagus ovinus* (L.), large numbers of keds have often been seen to die on sheep at Lethbridge Laboratory, Alberta, as a result of blockage of the posterior midgut by masses of crithidiae.

Curtis (L. C.). **Observations on a Black Fly Pest of Cattle in British Columbia (Diptera: Simuliidae).**—*Proc. ent. Soc. B.C.* **51** pp. 3–6, 1 map, 11 refs. Vernon, B.C., 1954.

Complaints were received late in the summer of 1951 that cattle in the Cherryville area of British Columbia were being severely attacked by Simuliids. The area lies isolated from other farming districts in a valley in the Monashee Mountains; it is about eight miles long and three miles wide and is traversed by a river with a tributary fed by smaller streams. The flies were apparently indigenous in the area, though they had earlier passed unnoticed by most farmers. The Simuliid responsible for attacks on cattle in other parts of Canada is *Simulium arcticum* Mall. [*cf. R.A.E.*, B **37** 122], but adults taken on the animals at Cherryville were identified as belonging to an undescribed species, though they closely resembled *S. arcticum*. Similar adults were stated to have been taken at Ione, Washington.

Observations indicated that the eggs overwinter and hatch when the temperature of the water reaches 38°F. Larvae were observed in the river on 1st March 1953 and a few pupae on 16th April, and a DDT emulsion concentrate was applied upstream at a rate affording one part DDT in ten million for 15 minutes. Pupae were appearing in the tributary streams by 1st May, and the same treatment was carried out in them. As a result,

almost all the larvae disappeared. Further treatments had to be applied to the river and main tributary at the end of June and to one of the streams in mid-July. The results appeared satisfactory, the attacks on cattle having been very much reduced.

Grégoire (C.). **Bases scientifiques de la lutte contre l'hypodermose bovine.** —*Parasitica* **11** no. 4 pp. 109–117. Gembloux, 1955.

Destruction of larvae of *Hypoderma lineatum* (Vill.) and *H. bovis* (Deg.) by all owners and keepers of cattle was made compulsory in Belgium in 1929, but this did not result in any reduction in infestation, and a Research Section was set up in 1949 by the Belgian Commission for the improvement of raw hides to investigate the bionomics of these flies and devise an effective method of control. Its work showed that larvae of *H. lineatum* are encysted in the backs of cattle from early February to the middle of June and those of *H. bovis* from March to August. The proportion of damaged hides for the country as a whole was about 25 per cent. in 1950 and 1951, with a maximum of over 40 per cent. in July in both years. Young animals were more often affected than older ones, and bulls and bullocks than cows, because the latter are generally indoors in the hottest part of the day when the flies are most active. The method of control adopted was to apply larvicides with a stiff brush to the backs of the cattle. In 1950, it was found that BHC (Gammexane) killed the larvae, but only at concentrations that were irritant and dangerous for mammals, and a proprietary phosphorothioate preparation of unstated composition was slow in action and ineffective, probably on account of inadequate powers of penetration, whereas rotenone at 0·2 per cent. gave 93 per cent. control. In the following year, the value of the addition to rotenone-containing emulsions of detergents, adjuvants such as toluene (at 0·4 per cent.) or even carbonic acid was established. The carbonic acid sets up local asphyxia, causing the larvae to open their spiracles to the fullest extent and thus facilitating penetration of the insecticide into the tracheal system. As a result of the findings, the recommended measure is the application with a hard brush of an emulsion of derris or cubé extract, with a rotenone content of 0·1–0·25 per cent. according to the amount of detergent used, and with the addition of toluene and carbonic acid. All cattle must be treated and two applications must be made while the larvae are under the skin.

A pilot project in the Province of Luxemburg in 1952–54 in which two annual treatments were made, one about the middle of April and one in early June, resulted in an annually progressive reduction in the percentage of animals infested and a much greater decrease in the number of larvae per animal. On 21st February 1955, a Royal decree made the control of *Hypoderma* by local authorities compulsory throughout Belgium. The first treatment was begun on 4th April of that year and a second was to be made in the second half of May. It was proposed to carry out this programme for five years, after which time it was hoped that stock-owners could be left to destroy the occasional larvae that might appear on their cattle.

Cragg (J. B.). **The olfactory Behaviour of *Lucilia* Species (Diptera) under natural Conditions.**—*Ann. appl. Biol.* **44** no. 3 pp. 467–477, 2 figs., 13 refs. London, 1956.

The causes of previously observed differences in the attractiveness to females of *Lucilia sericata* (Mg.) and those of *L. caesar* (L.) or *L. illustris* (Mg.) of various compounds exposed in traps and on sheep [*cf. R.A.E.*, B

33 167; **40** 182–184] and the behaviour reactions of the flies to sheep wool were investigated in northern England during 1951–55 by means of a two-choice apparatus. This consisted of two tanks of water, heated independently but having a single cover, and two sets of beakers, one set for each tank, that fitted through holes in the cover into the water. If the beakers contained sheep wool and the top of the apparatus was covered with it, the temperature gradient between the bottom of the beaker and the surface of the wool could be closely approximated to that between the skin and the surface of the wool of a living sheep (39·4–21·8°C. [about 103–71°F.]). The apparatus was usually set up in close proximity to sheep. The attractants used were mixtures of ammonium carbonate with indole and of ethanethiol (ethyl mercaptan) with hydrogen sulphide, and are referred to below as ACI and S (sulphydryl-type) mixtures, respectively.

When the beakers contained an ACI mixture (2 per cent. ammonium carbonate with 0·4 per cent. indole) and a cotton-wool plug, and only one set was warmed, the numbers of egg batches deposited in two hours in the warm and (in brackets) cool beakers were 51 (7) and 23 (2) in two experiments in which the cover on the tanks was wool, 16 (0) in one in which it was metal and 3 (0) in one in which it was hessian. If the whole apparatus was unheated, females of *L. sericata* would occasionally be attracted by the presence of ACI mixture and wool and might remain and explore the surface for three or four hours without ovipositing, but would settle in the beakers and prepare to oviposit if the sun heated the mixture to 30°C. [86°F.] or more. In a test in which ACI and S mixtures were exposed alternately for two-hour periods in the presence of wool *L. sericata* was attracted mainly by the former and *L. caesar* by the latter, but in the absence of wool both species were attracted by both mixtures, though *L. sericata* rarely started pre-oviposition behaviour. In suitable weather, *L. sericata* responded readily to ACI mixture in the presence of wool throughout the season and always oviposited if the temperature of the mixture was 35–40°C. [95–104°F.], but *L. caesar* and *L. illustris* did not exhibit full oviposition response until the season advanced. In 1954, when the tests were made on all suitable days from 20th July to 3rd September, these two flies were attracted in numbers by S mixture, but oviposition by them was first observed on 11th August, and then increased progressively until 27th. In 1955, when the tests were begun on 19th August, these flies oviposited in large numbers next day and in even greater numbers on two successive days in early October, when they were so strongly attracted by the S mixture that many of them died in the beakers or in the wool covering the apparatus.

Cores of sheep wool clipped close to the skin and exposed for three weeks in beakers containing enough water to maintain humidity throughout the staple did not attract flies to oviposit, even under the most favourable conditions, and it is therefore probable that if bacterial activity promotes oviposition on sheep [*cf.* **40** 183], it must be associated with the skin and not with the wool fibres.

The behaviour of the flies in relation to the attractant materials is described from observations on marked females and divided into the phases of approach, searching and settling, preparation for egg laying, oviposition and post-oviposition. The low temperature threshold for approach of *L. sericata* was about 15·5°C. [59·9°F.] on dull days and 14°C. [57·2°F.] in sunlight [*cf.* **22** 95; **37** 208]. *L. caesar* and *L. illustris* were active at lower temperatures. *L. sericata* approached S mixture in the presence of wool, but seldom showed the searching response to it. Some flies completed the searching phase in 5–20 minutes, but others did so during two or more visits to the apparatus, with intervals of 55–255 minutes between the first

and last. Flies disturbed in the searching phase tended to return to the apparatus even if the attractant and wool were removed from it, and females of *L. caesar* could usually be found in the morning on or near an apparatus in which S mixture had been used when their activity was declining in the late afternoon of the preceding day. Preparation for oviposition and the actual process together occupied 12–25 minutes, and females showed a strong tendency to oviposit near others already doing so; tests showed this to be a response to the presence of the females, not of the egg batches. The flies usually left the apparatus within a minute of ovipositing and did not return on the same day.

In a discussion of his previous findings [**40** 182–184] in the light of the present work, the author points out that the amount of oviposition on sheep bearing pads impregnated with a sulphydryl compound (as the attractant) and ammonium carbonate (as the oviposition stimulus) is not an accurate measure of attraction, since the presence of wool and ammonium carbonate would not stimulate oviposition by *L. caesar* and *L. illustris* so that their attraction would not be recorded. The rarity of oviposition by these flies in the trap experiments [**40** 183] is explained by low temperatures. Among British blowflies, *L. sericata* is the most strongly attracted by the presence of wool [see next abstract] and is therefore the most efficient at locating sheep. Its strong wool reaction probably causes it to congregate near sheep flocks, and if sufficient organic sulphur compounds, hydrogen sulphide and carbon dioxide accumulate in the fleece, gravid females will tend to settle on the sheep, especially if large numbers of flies are present. Fleece temperature and the presence of other ovipositing females, as well as of ammonia and carbon dioxide [*cf.* **40** 183], are of importance in stimulating oviposition. The processes whereby volatile attractants are produced on the sheep under natural conditions are not understood.

Cragg (J. B.) & Cole (P.). **Laboratory Studies on the Chemo-sensory Reactions of Blowflies.**—*Ann. appl. Biol.* **44** no. 3 pp. 478–491, 3 graphs, 12 refs. London, 1956.

The reactions of *Lucilia* spp. and *Calliphora vomitoria* (L.) to sheep wool and to chemical attractants used in field tests [see last abstract] were investigated in the laboratory by means of a two-choice chamber. This consisted of a circular Perspex tray, 28 cm. in diameter and 1 cm. deep, that fitted into a glass trough so that the rim of the trough was 2 cm. above the rim of the tray. The tray was partitioned into two equal compartments, of which one contained the test material and the other activated charcoal, and was covered with tightly stretched muslin so that a glass plate put over the trough containing it formed the roof of a chamber in which a fly could move freely on the muslin floor. The flies were tested singly and the attractiveness of the material was assessed by counting the number of seconds in a ten-minute period spent over it by each of a group of ten. The apparatus was rotated after five minutes to reverse the two halves, and was illuminated by a lamp directly over it.

Males of *Lucilia sericata* (Mg.) were not attracted to sheep wool, but females showed a strong reaction, the mean periods spent by different groups of ten over different kinds and quantities (2·5–5 gm.) of wool ranging from 395 to 501 seconds (68–85 per cent. of the total period). The attractiveness of wool was not reduced by storage for two years, and was not completely removed by washing in hot, soapy water and ether. Fertilised females fed on meat daily gave the strongest reaction, but unfertilised females gave some response, the intensity of which was not affected by a

meat diet. After oviposition, females fed on meat maintained a high level of response for four weeks, but the reaction of others fed only on sugar solution gradually weakened, though when meat was provided once a week it increased temporarily after the meal. The reaction of *L. sericata* was not affected when the muslin floor of the chamber was damp instead of dry.

Comparative tests showed a significant reaction to sheep wool in strains of *L. sericata* from Britain, Australia, a country area in Denmark in which this species will oviposit on sheep [*cf. R.A.E.*, B **38** 124] and Copenhagen, and, provided that the muslin floor was damp, in an Australian strain of *L. cuprina* (Wied.), a slight reaction in British strains of *L. illustris* (Mg.) and *L. caesar* (L.), and no reaction in a British strain of *C. vomitoria*. The reaction of the British strain of *L. sericata* was greater than that of the Danish country strain and significantly greater than those of the Copenhagen and Australian strains. The reaction of *L. cuprina* was about equal to that of the British *sericata*, but it showed no reaction on a dry floor, being the only species affected by humidity, and its reaction was increased, and that of *cuprina* virtually eliminated, by reduced illumination. The British strain of *L. sericata*, used as a standard throughout this work, was derived from larvae obtained from sheep a year before, but flies of the same species collected on sheep on the day before testing and others reared from larvae collected from domestic refuse in central London did not differ significantly from it in their reactions to wool. There was also no change in the intensity of the reaction of any of the strains or species after they had been reared for several generations in the laboratory. The olfactory organs involved in the response to wool were found to be mainly on the antennae, but adults of *L. sericata* and *L. cuprina* from which the antennae and some tarsi were removed still showed some response if they were tested on a damp floor. The main humidity receptors were also found to be on the antennae.

In tests of the influence of larval feeding on the response to wool [*cf.* **32** 175–176], adults of *L. sericata* and *L. cuprina* reared from larvae from sheep were only slightly more attracted to wool than flies from stocks reared on raw liver or a blood medium and the difference disappeared as the flies aged and also in their progeny when reared on a meat diet through two generations. In a test with *L. illustris*, which had shown no significant wool reaction but has been reported to produce myiasis in sheep [**31** 150], adults from a culture reared on blood medium mixed with sheep wool over six generations were not significantly more attracted to wool than others reared on the blood medium alone.

Chemicals were tested as solutions on a folded filter paper that filled one half of the tray, and the muslin was kept damp. The flies used were *L. sericata* and *L. illustris*, but the expected differences in their reactions [*cf.* preceding abstract] did not appear. Both species showed a similar slight, but variable, response to ethanethiol with hydrogen sulphide, and the response of *L. sericata* to the mixture in the presence of sheep wool was similar to its response to wool alone. The mean responses of *L. sericata* to a mixture of ammonium carbonate and indole were very little higher than those of *L. illustris*, though there were marked differences between individuals of the former, and the mixture did not induce oviposition by gravid females.

It is concluded from these and the field studies that there is associated with wool an olfactory stimulus additional to that provided by the volatile substances previously tested. The relative strength of the wool reaction in the different species and strains investigated appears to conform with their reported relative efficiency as producers of myiasis in sheep [*cf.* **31** 150; **33** 181; **40** 184]. The results do not support the view that some strains of

L. sericata produce myiasis and others do not, since all strains included individuals with a strong wool reaction, but suggest that the myiasis-importance of a given population of the species depends on the proportion of such individuals in it. It is possible that competition for breeding sites in districts with high sheep densities may have led to prolonged selection of strains with a high wool reaction, but that this reaction may not be of major importance in survival under some conditions.

MacLeod (J.) & Donnelly (J.). **Methods for the Study of Blowfly Populations. II. The Use of Laboratory-bred Material.**—*Ann. appl. Biol.* **44** no. 4 pp. 643–648, 2 refs. London, 1956.

When the release-recapture method is applied to the study of numbers or behaviour of wild populations of insects [*cf. R.A.E.*, B **44** 113], it is preferable, but not always practicable, to use the native material for marking and release, rather than unacclimatised laboratory-bred stocks, which may differ in behaviour and viability. The authors have been using the method for studies of blowflies in northern England [*cf. loc. cit.*], and differences in availability of protein in particular might be expected to cause significant differences between field and laboratory populations of these insects, influencing the physiological categories of the females and probably also the behaviour of those that are gravid. If the protein response is determined by a hunger-cycle or feeding rhythm, it should be much more uniform in members of a cage colony, to all of which protein has been equally available, than in a sample of wild flies. To a smaller extent, a wild sample kept in a cage for a day or more is somewhat conditioned to a uniformity of protein-hunger, and ceases to be representative of the population from which it was drawn. A study was therefore made of the effect of varying the period between the last protein meal and release on the proportion of liberated flies recovered in meat-baited traps.

In July 1955, blowflies were trapped on two successive days, identified to genus and distributed between four cages with sugar and water. Meat was added to all cages on the third day and removed on the fourth, fifth or sixth day or left until the evening of the seventh day, when all the flies were released. Reared flies in a fifth cage were provided with protein up to the time of release. All flies were marked with radioactive phosphorus on the sixth and seventh days and powdered with different coloured dyes immediately before release. Recaptures failed to provide evidence that the differences in opportunity to feed on protein produced any difference, apparent in the first four days, in the response of the groups to protein baits. Also, there was no noticeable difference in behaviour between the laboratory group and the wild groups. Thus, it appears that no true differences between the wild groups were being masked by variability within them in respect of their history before their conditioning.

Recovery rates for wild and laboratory-bred flies in this and nine other experiments are shown in a table. The reared material generally gave the same order of recapture rate of the total release as the wild material. In four of the experiments, at least one species group was represented in both wild and laboratory-bred release lots. The recapture rates for these species groups, which can be directly compared, were sometimes higher and sometimes lower in the laboratory-bred samples than in the comparable wild-caught samples. The nature of the difference was apparently associated with differences in the effects of the weather conditions of the release areas on the laboratory and field (acclimatised) flies, but other causes, probably including physiological debilitation as a result of confinement, may also be involved.

Wilkinson (P. R.). **Observations on Infestations of undipped Cattle of British Breeds with the Cattle Tick, *Boophilus microplus* (Canestrini).** —*Aust. J. agric. Res.* **6** no. 4 pp. 655–665, 4 figs., 13 refs. Melbourne, 1955.

The following is virtually the author's summary. A small herd of cattle of British breeds infested with *Boophilus annulatus microplus* (Can.) was kept in a previously unstocked paddock in Queensland for 11 months without treatment for tick control. Frequent examinations showed that widely differing numbers of ticks developed on the cattle. The "tick resistance" of one animal, on which no adult ticks were found during the summer months, could be accounted for only by mortality of the larvae and nymphs on it, since as many larvae were seen on selected small areas of this animal as on some carrying many adult ticks. The cattle grazed together and thus would encounter similar numbers of tick larvae. The degree of susceptibility to infestation by adult ticks showed negligible correlation with skin thickness measurements and was not related to hair length.

Larvae reappeared on the cattle six weeks after the first stocking of the paddock in March. The animals became almost free of ticks for two weeks in August. Although larvae were most numerous in November and December, they gave rise to fewer adults than the earlier wave of larvae in September and October. Some of the cattle suffered from "tick-worry" in October, but thereafter their condition improved without treatment.

Hitchcock (L. F.) & Roulston (W. J.). **Arsenic Resistance in a Strain of Cattle Tick (*Boophilus microplus* (Canestrini)) from northern New South Wales.**—*Aust. J. agric. Res.* **6** no. 4 pp. 666–671, 14 refs. Melbourne, 1955.

The following is based on the authors' introduction and summary. The status of the resistance to arsenic long known to occur in *Boophilus annulatus microplus* (Can.) on cattle in Queensland [*R.A.E.*, B **36** 103, etc.], is now somewhat obscure, on account of the widespread substitution of chlorinated-hydrocarbon acaricides for arsenic, but the recent discovery of a strain of the tick that could not be controlled by dips containing 0·2 per cent. arsenic trioxide in an area in northern New South Wales, where arsenic had been used exclusively [*cf.* **42** 78], allowed of the study of arsenic resistance uncomplicated by exposure to other acaricides. The concentration of arsenic needed to prevent 50 per cent. of the engorged females of this strain from laying viable eggs and that required to kill 50 per cent. of the larvae were both about double those required for a reference strain.

Orlov (E. S.). **Brucellosis of agricultural Animals.** [*In Russian.*]—*Veterinariya* **33** no. 6 pp. 33–35. Moscow, 1956.

Abstracts are given of several contributions on brucellosis of domestic animals in the Soviet Union. Those concerned with arthropod vectors of the disease are noticed below.

Tevosov (A. M.) & Annagiev (A. A.). **Contribution to the Problem of natural Nidi of Brucellosis** (p. 33). In investigations in Azerbaijan on the rôle of ticks as vectors of brucellosis, four species were collected from cattle

and two from sheep on affected farms, and suspensions of the 1,170 examples available were injected into guineapigs. Serological tests of the latter were conducted twice in the course of 35–45 days, and the animals were then killed and investigated bacteriologically. The results were negative except for a single isolation of *Brucella abortus* from one batch of *Hyalomma excavatum* Koch (*anatolicum* Koch) collected from infected cows, and a positive agglutination test at a titre of 1:160 for one guineapig. The disease was eradicated from several farms in 1952–53, and no further cases occurred, although infestation by ticks was high.

Kolomakin (G. A.). **The Significance of Ixodid Ticks in the Epizootiology of Brucellosis** (p. 33). On a farm on which brucellosis was common in sheep, suspensions of Ixodid ticks collected from hares, a bull kept with infected sheep, and sheep in which brucellosis had caused abortion, and larvae and adults that were the progeny of ticks collected from sheep within five days of abortion, were injected into guineapigs, and the latter were investigated serologically over 30–50 days and then killed and examined bacteriologically. The results were negative. Two batches of *Dermacentor* from sheep in which abortion had occurred were reared to the adult stage and placed on guineapigs. The latter showed positive agglutination tests after 30 days, at titres of 1:40 and 1:160, but no strains of *Brucella* could be isolated from them after death. A further experiment with ticks of the same series gave negative results. Females of the same series were allowed to engorge on an artificially infected sheep and to oviposit. Adults reared from the eggs were placed on two guineapigs; the latter gave positive agglutination tests after 30 days, at titres of 1:25 and 1:60, and a culture of *Brucella* was isolated from one of them.

Kogan (I. Ya.). **Comments on a Paper . . . by P. I. Pritulin** (pp. 33–34). Commenting on a paper already noticed [*R.A.E.*, B **43** 145], the author asserts that, so far as he is aware, there is no locality in which both *Dermacentor nuttalli* Olen. and *Hyalomma marginatum* Koch would be found infesting cattle. Observations for four years on an infected farm indicated that ticks are of no importance in the transmission of brucellosis, outbreaks of which are usual in the second half of winter and in early spring, and not in summer, in spite of heavy infestation by *Dermacentor* spp.

Trilenko (P. A.). **Letter to the Editor commenting on a Paper by P. I. Pritulin** (p. 34). The validity of Pritulin's finding that examples of *Dermacentor nuttalli* Olen. and *Hyalomma marginatum* Koch transmitted brucellosis from cattle to guineapigs [*loc. cit.*] is questioned on the ground that the criteria of infection of the guineapigs were inadequate.

Nazarov (G. S.). **Control of Mange of Rabbits and Cats by Dusting.** [*In Russian.*]—*Veterinariya* **33** no. 6 pp. 43–46, 2 figs. Moscow, 1956.

As preliminary tests showed that a fine dust comprising 6 per cent. technical BHC, 50 per cent. sulphur and 44 per cent. talc was much more effective against *Psoroptes cuniculi* (Delafond) *in vitro* than dusts of DDT, sulphur or naphthalene, and that treatment of the whole body with dusts of sulphur, 12 per cent. BHC or 10 per cent. DDT was harmless to cats and rabbits, cats infested by *Notoëdres* and rabbits infested by *P. cuniculi* were dusted with sulphur, rabbits and cats infested by *Notoëdres* and rabbits infested by *P. cuniculi* with the mixed dust, and a cat infested by *Notoëdres* with 10 per cent. DDT. Treatment against *Notoëdres* was carried out by rubbing the dust into the fur with the hands while the animal was held on a table, and that against *P. cuniculi* by pouring a little of the dust into each

ear in turn and rubbing it into the skin, followed by precautionary treatment of the outside of the ears and the fore part of the body. The treatments were repeated after five days. The animals infested by *Notoëdres* were examined 4–5 days after the first application; bleeding from the lesions had ceased, or almost so, and skin had covered those from which the scabs had separated. Skin scrapings and scabs were microscopically examined for the occurrence of living mites a fortnight after the first treatment, and observations as to the final recovery of the animals were made for four months. The results of these examinations are not given, but it is concluded that *Psoroptes* can be controlled by a single application of sulphur or the mixed dust and *Notoëdres* by one application of the latter. Sulphur dust proved effective against *Notoëdres*, but three applications at intervals of 5–7 days would be required. DDT was less effective.

Three rabbits infested by *Notoëdres* and *P. cuniculi* were treated with the mixed dust by rubbing it into the skin of the head; the ears were left untreated internally in order to detect a possible fumigant effect. Subsequent examination showed no living mites in skin scrapings and scabs from the heads of the animals, but living mites were still present in the ears.

Tolstyak (I. E.). **Transmission of Swine Erysipelas by the Bites of *Stomoxys calcitrans*.** [*In Russian.*]—*Veterinariya* **33** no. 6 pp. 73–75. Moscow, 1956.

In view of a report of the transmission of swine erysipelas to healthy pigs by the bite of stable flies (*Stomoxys calcitrans* (L.)) that had ingested the blood of mice killed by the disease, further experiments were carried out in 1952–53. Stable flies caught 2–5 hours previously were kept in tubes closed with gauze, and allowed to feed on the blood of white mice artificially infected 68 hours before, or of white mice killed by the disease, and then on healthy mice. Infections resulted in the majority of the cases. Further tests were carried out with young pigs, and in one, of which the results are given in tables, stable flies that had fed on a mouse killed by the disease were allowed to feed on various parts of the body of a healthy pig, the periods between the two feeds varying up to 30 seconds. All the parts fed on became typically discoloured and swollen in 38–46 hours, the animal developed a high temperature and other symptoms, and a pure culture of the bacterium was isolated from its blood. On the fifth day, when the fever was at its height, stable flies were allowed to feed on the swellings, and transferred after intervals ranging up to eight minutes to various parts of the body of a healthy pig. This animal became similarly infected, swellings and discoloration appearing in 36 hours at all the sites of feeding, and the bacteria were subsequently cultured from its blood.

In the second experiment the disease was similarly transmitted by stable flies from an infected mouse to a young pig and from the latter to two further pigs. The symptoms in these two pigs were much milder and there was no rise in temperature in one, which suggested that they might have previously undergone a latent form of the disease and acquired some resistance to it, especially since the bacterium was isolated from a dead pig of the same litter and they appeared backward in growth.

It is concluded that blood-sucking insects might be of importance in transmitting erysipelas under natural conditions, a view supported by the periodical fluctuations observed in its epizootology in some years and by the seasonal character of its occurrence, and therefore that the control of these insects by treating pigs with DDT or BHC should be included in the measures taken for the eradication of the disease.

Cefalù (M.) & Terminello (L.). **L'*Anopheles algeriensis* Theobald in Sicilia.**—*Riv. Parassit.* **15** no. 4 pp. 323–330, 2 figs., 16 refs. Rome, 1954. (With a Summary in English.)

The Anophelines formerly known in Sicily were *Anopheles maculipennis labranchiae* Flni., *A.* (*Myzomyia*) *superpictus* Grassi and *A. claviger* (Mg.), but adults and larvae of *A. algeriensis* Theo. were found in two provinces (Syracuse and Enna) between July 1952 and June 1954. The adults were taken in all months from April to July and in November and December and occurred under bridges and in caves, empty and inhabited dwellings and sheds for animals. All the winter collections of which the origin was recorded were from sheds and some of them included males. The adult, larva and egg are described, and notes are given on the habits of the species and its general distribution, which includes the whole of the Mediterranean area. It is usually of sporadic occurrence, which makes it difficult to locate, and its finding in Sicily is attributed solely to intensification of surveys.

Cwilich (R.) & Mer (G. G.). **Determination of the Age of the Housefly *Musca domestica vicina* Macq. by the Persistence of larval Fat Body Cells in the Imago.**—*Riv. Parassit.* **15** no. 4 pp. 357–359, 1 ref. Rome, 1954. (With a Summary in Italian.)

Dissection of the fifth and following abdominal segments of adults of *Musca domestica vicina* Macq. of both sexes 1–4 days after emergence showed that the number of larval fat-body cells in them decreased with age. Very few remained on the fourth day, and none was found thereafter. The mean diameter of the cells decreased from 110 μ in males and 120 μ in females on the first day to 80 μ in males and 70 μ in females on the third day. The flies were kept at 25–26°C. [77–78·8°F.] and 65 per cent. relative humidity. Those dissected on the first three days were given only water, but those dissected on the fourth day were supplied with sugar and dried milk from the time of emergence. It is suggested that examination for the presence of fat-body cells may be useful in determining the prevalence of newly emerged adults in fly populations, a point of importance in assessing the effects of control operations.

D'Alessandro (G.). **Studio di un habitat montano dell'*A. labranchiae* in Sicilia.** [Study of a mountain Habitat of *Anopheles maculipennis labranchiae* in Sicily.]—*Riv. Parassit.* **15** no. 4 pp. 361–372, 8 figs., 5 refs. Rome, 1954. (With a Summary in English.)

The following is based on the author's summary. A mountain habitat of *Anopheles maculipennis labranchiae* Flni. at an altitude of about 4,000–6,000 ft. on Mount Sori in the Messina Province of Sicily is described. The area was wooded and sparsely populated, and observations in August 1954 revealed the existence of a dense, pure population of the mosquito living under natural conditions, independent of man-made resting places. Adults of both sexes were resting in holes in old trunks and roots of beech trees, while none could be found in the few houses in the neighbourhood. It is concluded that the domestic and anthropophilous characters that are generally shown by this mosquito are a secondary adaptation, that it has never lost its ability to live in natural surroundings, and that the destruction by insecticides of the part of the adult population that shelters in dwellings is increasing the tendency to rest out of doors [*cf. R.A.E.*, B **43** 44, 176–177].

Mariani (M.) & Cefalù (M.). **Sul modo di svernare dell'*Anopheles labranchiae* in Sicilia in condizioni di vita extra-domestica.** [On the Method of Overwintering in *A. maculipennis labranchiae* in Sicily under non-domestic Conditions.]—*Riv. Parassit.* **15** no. 4 pp. 485–488, 10 refs. Rome, 1954. (With a Summary in English.)

It is known that the activity of females of *Anopheles maculipennis labranchiae* Flni. is not completely suspended in winter [*R.A.E.*, B **22** 97], and investigations on this mosquito in natural habitats in Sicily remote from human influence [*cf.* preceding abstract], principally in a focus in Palermo Province, confirmed that, even under such conditions, it does not undergo a true diapause. Females that showed blood in the gut and others that had ovaries at various stages of development up to the fifth [*cf.* **29** 93] were found during January and February in narrow shelters such as small slits and holes in rocks.

Milani (R.). **Comportamento mendeliano della resistenza alla azione abbattente del DDT e correlazione tra abbattimento e mortalità in *Musca domestica* L.** [Mendelian Behaviour of Resistance to the knockdown Action of DDT and Correlation between Knockdown and Mortality in *M. domestica*.]—*Riv. Parassit.* **15** no. 4 pp. 513–542, 1 fig., 28 refs. Rome, 1954. (With a Summary in English.)

Two characters are common in house-flies (*Musca domestica* L.) in a part of Italy (Latina) in which DDT and other contact insecticides have been intensively used. One is resistance to knockdown (as well as kill) by DDT, and the other is an abnormality of the wing veins (plexus), evidenced by supernumerary small veins, sometimes in a network, and by thickenings and irregularities on the transverse posterior vein. A strain of these flies, derived from a single female, was reared for experiment and selected by inbreeding to augment the plexus character. It retained a high resistance to knockdown by DDT though it was not exposed to it in the laboratory.

The mode of inheritance of the two characters was studied by crossing this plexus strain with two (Tripoli and orange) that did not possess them. The Tripoli strain was derived from flies collected near Tripoli and was always kept in mass culture, but the orange strain was derived from a single female taken from the same population as the plexus strain, and was selected initially for an orange coloration of the body. It is concluded that the inheritance of resistance to knockdown by DDT is monofactorial [*cf. R.A.E.*, B **41** 123, 124; **42** 7] and does not appear to be sex-linked. Knockdown of the F_1 generations was almost as rapid as that of the susceptible parent strains, but flies of the F_2 generations, obtained by incrossing each hybrid strain and back-crossing plexus × Tripoli to plexus, could be divided into two groups, one in which knockdown was complete in 75–95 minutes and the other in which it did not begin within 2·5, 3·25 and over 10 hours, respectively. By exposing survivors of two of the F_2 generations (the plexus × Tripoli incross and the back-cross) to DDT for a second time, 2–4 days after the first exposure, it was confirmed that the characters remained stable for the individuals, only two of the 597 flies classified as knockdown-susceptible being found to be resistant at the second exposure, and none of about 300 classified as resistant proving susceptible. It was concluded that the technique used in the classification was satisfactory.

All the F_2 generations obtained in mass cultures, either by incrossing or back-crossing, gave regular mendelian segregations, but irregularities in segregation occurred in some of the series of F_2 obtained by incrossing single pairs and in one series that had been back-crossed, the irregularities within one series being all of the same type.

Investigation of the correlation between knockdown-resistance and resistance to kill showed the percentages of males and females of the F_2 generation that died within 48 hours of their exposure to DDT were 2·19 and 0·27 in the flies resistant to knockdown and 77·82 and 53·6 in those susceptible to it. The extremes of mortality of the knockdown-susceptible flies occurred in the crosses involving the Tripoli strain. There was a significant difference between the mortality in the two sexes in crosses with this strain, the percentages for males and females, respectively, being 84·9 and 50·16 in the incrosses and 90·9 and 33·33 in the back-crosses to plexus. With this one exception, mortality was significantly higher in all the incrosses than in the back-crosses.

The plexus character did not give regular mendelian segregations. It appears possible that it is associated with the character of resistance, and selective breeding to augment it was accompanied by a high degree of tolerance to DDT. After crossing flies showing the plexus character with those of the Tripoli strain, mortality was significantly higher in normal segregants of the F_2 generation than in those showing the plexus character.

The author discusses the need to differentiate between resistance to knockdown and resistance to kill since it has been shown that some flies that are susceptible to knockdown are resistant to kill. He examines the results of the experiments of D'Alessandro & Mariani [**44** 203], who assumed that all the flies knocked down were also killed, and concludes that they do not disprove the theory, supported by the work of other authors [**41** 123, 124; **42** 7], that resistance to knockdown is monofactorial.

Mosna (E.) & Alessandrini (M.). **L'impiego degli esteri fosforici nella lotta contro la mosca domestica nella Provincia di Latina.** [The Use of phosphoric Esters for the Control of *Musca domestica* in the Province of Latina.]—*Riv. Parassit.* **15** no. 4 pp. 543–556, 2 graphs. Rome, 1954. (With a Summary in English.)

House-flies [*Musca domestica* L.] in the Province of Latina have become resistant to chlorinated insecticides and tests on control were therefore carried out with deposits of Diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] and malathion. In laboratory tests in 1952, deposits of Diazinon gave complete knockdown within ten minutes of flies of DDT- and multi-resistant strains as well as susceptible ones, when applied at a rate as low as 0·05 gm. per sq. m. There was no recovery from knockdown. A deposit of 0·1 gm. per sq. m. was still completely effective after one week, and one of 1 gm. remained very effective after five. A deposit of 0·2 gm. Diazinon and 1·4 gm. DDT per sq. m., obtained by application of a suspension of a paste containing 10 per cent. Diazinon and 75 per cent. DDT, was effective for about six weeks. Malathion was also effective against flies of all strains but required a higher rate of application. A deposit of 0·4 gm. per sq. m. began to lose its effectiveness in the second week and was almost ineffective at the end of the third.

Further tests were carried out in the laboratory to investigate the effectiveness of Diazinon on bundles of branches with evergreen leaves (holm oak) that could be placed in rooms. When a bundle about 2–2½ ft. long and 1–1½ ft. in diameter, sprayed with 1 gm. Diazinon, was fixed at the centre of one wall of a closed room with a capacity of about 2,100 cu. ft., complete knockdown of flies introduced was obtained within two hours during the first three days and in a longer period on successive days. Knockdown was no longer complete within 24 hours after eight days, and most of the flies survived after 15 days. The rapid knockdown in the first few days was in part due to the fumigant action of Diazinon, as flies in gauze cages in corners

of the room were knocked down almost as rapidly as those that were free to come into contact with the bundles. In subsequent tests in which the rooms were not airtight, there was hardly any fumigant action and the knockdown of the uncaged flies occurred after 3–4 hours. Fumigant action was also negligible, even in an enclosed space, when Diazinon was sprayed on walls that had been plastered with lime. Monkeys, rats and mice showed no symptoms of poisoning when kept for five months in a room with a capacity of about 1,400 cu. ft. containing successive bundles of branches that were sprayed daily with 2 gm. Diazinon.

In 1953, tests were carried out in a rural area near Latina. In 385 houses, the walls of kitchens, entrances and animal quarters were sprayed three times, at intervals of 40 days, with a suspension containing 3 per cent. DDT and 0·41 per cent. Diazinon, applied to give 0·18 gm. Diazinon per sq. m. In 98 houses, a 1 per cent. malathion emulsion spray was similarly applied six times, at intervals of 20 days, to give 0·4 gm. malathion per sq. m. In a third sector, 1,851 bundles of branches were divided among 302 houses, 1–2, 1 and 3–4 being placed in the kitchen, entrance and animal quarters, respectively. They were sprayed eight times, at intervals of 15 days, with the DDT-Diazinon suspension, to give an average of 1 gm. Diazinon per bundle per treatment. Some 20 houses were left untreated as controls. Weekly counts were made of the flies caught during 24 hours on fly-papers hung in the centre of a room, preferably the kitchen, in a number of houses in each sector. The weekly average numbers caught were 484–628 in mid-June, just before the first treatment and 14–67, 6–55 and 14–85 in the three treated areas, respectively, between the first treatment and the end of September, as compared with 536–774 during the same period in the controls. The cost of control with Diazinon and malathion was almost double that when chlordane was used.

No symptoms of poisoning were observed in the six workers who applied the sprays, in the inhabitants of treated houses or in any of the domestic animals, which were not removed when the sprays were being applied. Examination of blood from the workers after four months of applying the sprays, however, showed 46–59 per cent. inhibition of the cholinesterase activity in five of them; the activity was normal in the only worker who wore a mask during the operations.

In 1954, tests with malathion were discontinued since the frequent applications necessary made it uneconomic. The DDT-Diazinon paste was applied to walls at the same rate as in 1953, but only two applications were made, at an interval of 60 days. The treatment was applied to 1,148 houses in a rural area, and the numbers of flies present in both treated and untreated rooms were very low for four months, a slight but temporary increase being observed shortly before the second application. It was also noted that flies were almost completely absent from the town of Latina, which, although untreated, was surrounded by treated areas.

In 1954, the DDT-Diazinon paste was also used, instead of DDT, for the annual treatment against Anophelines that had been carried out throughout the malarial zone of the Province since 1946. The spray was applied in the second half of July, to kitchens, entrances and animal quarters, the rate of application giving an average of 0·17 gm. Diazinon per sq. m. Weekly counts of flies taken in these houses confirmed that Diazinon remains fully effective against them for about 40 days, but is ineffective after 60.

Workers applying the sprays were required to adopt specified precautions, including the wearing of protective clothing. All used masks, but the frequency with which the filters were changed varied considerably. Weekly tests for blood cholinesterase activity showed a decrease in men using masks in which the filters remained unchanged for more than 21–28 working days,

but the activity increased to its normal level when the filters were changed every 12 working days. No symptoms of poisoning were observed in any of the workers, and it is concluded that the protective measures taken were adequate. Cholinesterase activity in inhabitants of treated houses, tested 2–60 days after the treatments were carried out, was similar to that in people in untreated areas.

RAFFAELE (G.). **Su *Anopheles hispaniola* e specie affini del gruppo *Paramyzomyia*.** [On *A. hispaniola* and related Species of the Group *Paramyzomyia*.]—*Riv. Parassit.* **15** no. 4 pp. 601–604, 7 refs. Rome, 1954. (With a Summary in English.)

In view of discrepancies in the descriptions of various stages of *Anopheles hispaniola* (Theo.), the author studied the eggs and larvae of the species most closely related to it. The adults and larvae of the Anopheline from Calabria that he described as *A. italicus* [*R.A.E.*, B **16** 177] were similar to those of *A. hispaniola*, but it was considered a distinct species because the eggs lacked floats and so differed conspicuously from the description of the eggs of *A. hispaniola* given by Ed. & Et. Sergent in 1910. In 1937, however, Et. Sergent [**25** 215] corrected the description of the egg of *A. hispaniola*, the revised description agreeing with that of the egg of *A. italicus*. It is concluded, therefore, that *A. italicus* is a synonym of *A. hispaniola*.

In 1953, Aitken [**42** 112], described the eggs of a Sardinian Anopheline that he believed to be *A. hispaniola*. These eggs had a shining oval frill on the larger end. The author has examined material from Sardinia and concludes that the form of the egg and structure of the frill are similar to those of *A. cinereus* Theo. and totally different from the eggs of *A. hispaniola* (*italicus*), which have no frill.

A study of the larvae of *A. cinereus*, the Sardinian Anopheline and that described as *A. italicus* revealed little difference in chaetotaxy. The palmate hairs on the second abdominal segment had 5–7 leaflets in the first two and 2–3 in the third, and the apical filaments were very short in the latter and quite distinct in the other two. The larva of *A. turkhudi* List., with which Edwards had suggested that *A. hispaniola* was identical [*cf.* **39** 22], was easily distinguished from these three Anophelines.

The author concludes, on the characters of the egg and larva and also on a character of the mesonotum of the adults, which is covered with white scales, that the Sardinian Anopheline referred to as *A. hispaniola* [*cf.* **41** 206; **43** 44] is *A. cinereus*. The mesonotum of the adults described as *A. italicus* is almost bare.

ROUBAUD (E.). **Les larves léthales et leur signification dans le complexe *Culex pipiens*.**—*Riv. Parassit.* **15** no. 4 pp. 621–638, 1 fig., 18 refs. Rome, 1954. (With Summaries in English and Italian.)

The three main entities in the complex of *Culex pipiens* L. in Europe and North Africa that have been distinguished by the author [*cf. R.A.E.*, B **35** 119] are the rural *pipiens*, which is anautogenous, eurygamous (sometimes stenoeurygamous), heterodynamic and usually ornithophilous, though it also attacks bats in caves, *berbericus* Roub., which is anautogenous, stenoeurygamous, homodynamic and strongly anthropophilous, and *autogenicus* Roub. (commonly called *molestus* Forsk. [*cf.* **33** 94]), which is autogenous, strictly stenogamous and homodynamic, but is anthropophilous to varying degrees [*cf.* **21** 267]. Crosses between these various types and

between strains of a single type have often been reported to result in the production of sterile eggs [*cf.* **41** 119, 120; **43** 49], but the nature of the sterility has not usually been determined.

Microscopic study of unhatched eggs of a member of the *pipiens* group, a few days after the others in the batch have hatched, generally shows them to contain larvae that are destined to die within the chorion. The author proposes the designation "lethal larvae" for larvae of this type. Over a period of some 15 years, he has examined egg rafts of several *pipiens* strains from France, England and Belgium, a *berbericus* strain from Arles and 21 *autogenicus* strains from various parts of Europe and North Africa and found lethal larvae in some of the eggs of all the strains. One *berbericus* female laid five successive batches of eggs that contained no lethal larvae and a sixth of 25 eggs that contained 17. The production of lethal larvae was independent of external conditions or feeding or age of the female. Though they were sometimes made to hatch artificially, by mechanical or chemical means, their subsequent development generally remained blocked; they were thus quite different from the diapause larvae that occur in the eggs of some other mosquitos. Occasionally a few larvae that hatched normally from affected egg batches failed to develop normally, and in other cases eggs contained embryos that had died before completing their development.

The author considers that the lethal larvae are a manifestation of amixia operating between heterologous elements of the complex as a result of crossing. When various strains or types are crossed, signs of blocking appear in one or other direction or occasionally in both. Thus, when males of one of the two named morphological forms of *autogenicus* (*sternopunctatus* Roub.) were crossed with females of the other (*sternopallidus* Roub.) there was no evidence of inhibitory influence, but in the reciprocal cross all eggs contained dead embryos or lethal larvae. S. Ghelelovitch found that crosses between a Paris and a Hamburg strain of *autogenicus* were sterile in both directions, whereas crosses between the Hamburg strain and a Tunis strain were fertile. He is of the opinion that lethality is due to cytoplasmic incompatibility [*cf.* also **41** 120–121], whereas the author inclines to the view that the lethal factor is chromosomic because of its persistence in strains maintained for years without exogenous intercrossing. In either case, the production of lethal larvae in a given strain is proof of hybridisation in the near or distant past, and their occurrence is so general as to suggest that no pure strain of any type of *pipiens* now exists in nature, except perhaps in a few restricted areas. The hybridisation that is possible results in the production of secondary variations in behaviour, but these are limited by the reduction in the strains caused by the lethal effect of the mixing of different elements. Each of the differentiated elements of the complex represents a factor of biological disturbance for the others.

Swellengrebel (N. H.). **On *Anopheles plumbeus*.—*Riv. Parassit.* 15** no. 4 pp. 667–669, 2 refs. Rome, 1954. (With a Summary in Italian.)

The term "urban malaria" should not include malaria transmitted on the outskirts of towns by immigrant rural mosquitos or that transmitted by mosquitos that breed in the open in garden cities or in devastated towns, but should be restricted to malaria transmitted by mosquitos breeding under typically urban conditions, as in cisterns, closed tanks or deep wells. On this definition, the indigenous malaria recently discovered in London and attributed to transmission by *Anopheles plumbeus* Steph. [*R.A.E.*, B **44** 167] is not urban, as the mosquitos were presumed to be breeding in tree-holes.

In Amsterdam, on the other hand, *A. plumbeus* has been found breeding in the basement of a building to which the only access was through an opening in a wall [*R.A.E.*, B **34** 52]. The outbreaks of malaria that occur periodically in Amsterdam affect chiefly the outskirts, but a certain number of cases are detected each year among the inhabitants of the old town, separated from rural areas by a broad belt of newer houses. Some of these cases, though probably not the majority, must be locally acquired. If *A. plumbeus* should prove to be the vector involved, its occurrence in the old town would probably be due to its adaptation to breeding places of the urban type, as the only trees are those that grow in a few small private gardens.

DAVIDSON (G.). **Insecticide Resistance in *Anopheles gambiae* Giles.**—*Nature* **178** no. 4535 pp. 705–706, 6 refs. London, 1956. **Insecticide Resistance in *Anopheles gambiae* Giles: a Case of simple Mendelian Inheritance.**—*T. c.* no. 4538 pp. 863–864, 3 refs.

It is recorded in the first paper that a colony of *Anopheles gambiae* Giles was established in London from eggs received from an area of Northern Nigeria where the local population was recently reported to have developed resistance to dieldrin [*R.A.E.*, B **45** 13–14], and the susceptibility of this strain to a range of insecticides was compared with that of a laboratory strain originating from Lagos and maintained in London since 1951. These two strains and mosquitos belonging to them are designated R (or resistant) and S (or susceptible), respectively. The mosquitos were exposed to filter paper impregnated with various concentrations of insecticides in oil for 1 hour and mortalities were recorded 24 hours later. The median lethal percentage concentrations (MLC's) for the S and (in brackets) the R mosquitos were 0·4 (0·8) for pyrethrins, 0·6 (0·6) for DDT, 0·8 (1·4) for malathion and 0·007 (0·18) for γ BHC. Those of dieldrin and aldrin for the S strain were 0·08 and 0·2, respectively, but these two insecticides killed no R mosquitos at 4 per cent. The differences between the MLC's of pyrethrins and malathion for the two strains are thought to reflect merely the difference in size and vigour between them. To ascertain the degree of resistance to dieldrin, aldrin and related insecticides, exposure time had to be increased and the concentrations for the S strain decreased. Records of mortalities 24 hours after exposure for five hours show the R strain to be some 140 and 90 times as resistant to isodrin and endrin, respectively, as the S strain and at least 400 times as resistant to dieldrin. Aldrin and α and β chlordane tested against R mosquitos at concentrations of 4, 10 and 5 per cent. killed 2, 0 and 0 per cent. With an 18-hour exposure, the R strain was some 800 and 400 times as resistant to dieldrin and aldrin as the S strain, but the degrees of resistance to α and β chlordane could still not be assessed, since they gave 40 and 55 per cent. kill of S mosquitos at 0·01 per cent. and 19 and 8 per cent. kill of R mosquitos at 10 and 5 per cent., respectively. It is suggested that the tests in Nigeria [*loc. cit.*], which had indicated only some 8-fold resistance to dieldrin, were made with a mixed population of resistant and susceptible mosquitos and that the air journey to London killed all but the most vigorous eggs, which were those of highly resistant individuals.

In the second paper, an account is given of experiments on the manner in which the resistance was inherited. Crossings in both directions between the two strains produced hybrids that were identical and homogeneous in their susceptibility to γ BHC and dieldrin (the only insecticides tested). The MLC's of dieldrin for females and (in brackets) males with one hour's exposure were 0·08 (0·05) and >4 (>4) for the S and R mosquitos, and 2·6 (1·5) and 2·3 (1·6) for the RS and SR hybrids (hybrids of which the

female parents were R and S, respectively). Corresponding concentrations for γ BHC were 0·007 (0·006) for S, 0·21 (0·18) for R, 0·053 (0·038) for RS and 0·052 (0·038) for SR. Discriminating concentrations that would kill all S mosquitos but not hybrids were 0·33 per cent. for dieldrin and 0·025 per cent. for γ BHC and those that would kill all hybrids but not R mosquitos were 4 per cent. for dieldrin and 0·1 per cent. for γ BHC. Males of the F_1 generation were nearly all sterile, but the two types of hybrid females were back-crossed with S and R males. The offspring of the four possible back-crosses were exposed to the established discriminating dosages and the resulting proportions of susceptible and hybrid or hybrid and resistant mosquitos obtained. These, which are given in a table, were in all cases approximately 50 : 50 and show that the inheritance of resistance to the group of insecticides in question is monofactorial with incomplete dominance. This was confirmed by an experiment in which the offspring of the back-cross RS × S were exposed to a concentration eliminating susceptible individuals, the surviving females were crossed with R, and their offspring were exposed to the dosage killing hybrids. The surviving males and females from this latter exposure, on being crossed with members of the R strain, yielded pure resistant strains. It was also shown that the offspring of the back-cross of the hybrid with the S strain included no resistant individuals and that the offspring of the back-cross of the hybrid with the R strains contained no susceptible ones, since the concentration that kills hybrids gave complete kill of the former and the concentration that kills only susceptible individuals resulted in no kill of the latter.

This finding of a monofactorial inheritance of resistance indicates the need to change the method of detecting resistance in the field. A comparison of the LD50 of a particular insecticide in an insect population where resistance is suspected with that in a population where the insecticide has never been used may show only a small difference, depending on the proportions of susceptible, hybrid and resistant individuals in the population examined. The use of discriminating dosages in the experiments in Nigeria [*loc. cit.*] in which the LD50 indicated only an 8-fold resistance would have enabled a selection of the pure resistant strain, which is in fact some 800 times as resistant as the susceptible one. It is suggested that, instead of comparing LD50's, the minimum LD100 for the susceptible population should be established, and the suspected population be exposed to this dosage. If any survive, their offspring can then be reared and exposed to higher dosages to select the resistant strain. Alternatively, an accurate dosage/mortality regression line can be made in the suspected area, by the use of a large number of dosages. If resistance is present, it will be shown by two steps in the line where increase in dosage produces no change in kill. These are the discriminating dosages between susceptible and hybrid and between hybrid and resistant individuals.

Jeffery (G. M.), Young (M. D.) & Eyles (D. E.). **The Treatment of *Plasmodium falciparum* Infection with Chloroquine, with a Note on Infectivity to Mosquitoes of Primaquine- and Pyrimethamine-treated Cases.**—*Amer. J. Hyg.* **64** no. 1 pp. 1–11, 14 refs. Baltimore, Md., 1956.

Some 100 cases of malaria involving three strains of *Plasmodium falciparum* were treated with chloroquine administered orally or intramuscularly. Clinical response and reduction of asexual parasites in the blood were nearly always rapid. Appearance of gametocytes was prevented in all but four of 24 symptomatic cases treated before any were present, but gametocytes

persisted for 6–37 days after first treatment, with an average of 21 days, in 40 symptomatic cases treated after they had appeared. Relapses occurred in two cases of each group during the observation period of 2–6 months. After treatment of 33 asymptomatic parasite infections, gametocytes persisted for 6–33 days, except in four of the nine individuals in whom they were not present when treatment was initiated.

Mosquitos (*Anopheles quadrimaculatus* Say or *A. albimanus* Wied.) that were fed on ten cases after these had been treated with chloroquine, became infected for 4–20 days after treatment. Apparently, gametocytes may be infective to mosquitos after chloroquine treatment for as long as they occur in sufficient numbers. In all cases in which gland dissections were made, it was found that sporozoites matured normally in mosquitos infected from chloroquine-treated cases. Data are given for a few additional cases that were treated with primaquine in combination with quinine or chloroquine and for two treated with pyrimethamine alone and on which mosquitos were subsequently allowed to feed. The primaquine eliminated gametocytes within 13 (and usually within seven) days, and destroyed their infectivity much sooner than this. Pyrimethamine allowed gametocytes to persist in good numbers, but rendered them non-infective to mosquitos in one or two days.

HODGKIN (E. P.). **The Transmission of Malaria in Malaya.**—*Stud. Inst. med. Res. Malaya* no. 27, viii + 98 pp., 1 map, 6 graphs, 38 refs. Kuala Lumpur, 1956.

Intensive studies made between 1931 and 1941 to determine the species of *Anopheles* that are of importance in the transmission of malaria in Malaya are recorded in some detail in this work. In the introductory section, the geographical features of the country, its climate and population and the malaria situation are described, the common species of *Anopheles* are reviewed, and the state of knowledge on malaria transmission before 1931 is summarised. In the account of the investigations that follows, these are grouped according to the topographical regions in which they were carried out. The vector status of the various species as determined in this and earlier work is then discussed, and finally the relation of malaria transmission to topography is dealt with. The findings are summarised in 51 tables.

More than 90,000 mosquito dissections were carried out in the ten years. These included 17,424 of eight species (*A. aconitus* Dön., *A. karwari* (James), *A. kochi* Dön., *A. philippinensis* Ludl., *A. separatus* (Leic.), *A. subpictus malayensis* Hack., *A. tessellatus* Theo., and *A. vagus* Dön.) that are classed as non-vectors and in which the only infections found were in four of 5,020 females of *A. karwari*, one of 666 of *A. separatus* and one of 2,063 of *A. aconitus*. Other species studied, with the number of dissections and the number of gut and gland infections found in each, included *A. maculatus* Theo. (16,239, 51 and 91), *A. letifer* Sandosham (13,986, 64 and 61), *A. sundaicus* (Rdnw.) (12,474, 5 and 5), *A. baezai* Gater (1,865, 10 and 17) and *A. umbrosus* (Theo.) (3,435, 14 and 15). The remaining dissections (with numbers of positive guts and glands in brackets) were 6,097 (65 and 43) of mosquitos identified as *A. umbrosus* when a number of distinct species were confused under this name [*cf. R.A.E.*, B **39** 209], 8,775 (37 and 25) of collections of *A. barbirostris* Wulp believed to include vector and non-vector forms [*cf.* **34** 32], and 11,119 (14 and 7) of *A. hyrcanus* (Pall.) or related species, of the forms then designated vars. *sinensis* Wied. and *nigerrimus* Giles [*cf.* **41** 116–118].

There are shown to be certain definite types of transmission related to

topography. In the hills, transmission is effected mainly by *A. maculatus* and is associated with cleared land and cultivation, whether plantations, valley rice-fields [**26** 101] or small jungle clearings. *A. maculatus* is most abundant in March–April and malaria shows a major peak in May. *A. barbirostris*, *A. letifer* and *A. umbrosus* are all vectors on the coastal plain in places where the water is fresh. *A. umbrosus* is confined to the jungle swamps and their near vicinity, *A. letifer* occurs principally where the swampy jungle has been cleared, leaving a peaty soil with very acid water, and *A. barbirostris* is also found in the cleared areas but breeds in less acid waters than *A. letifer* and tolerates a greater degree of salinity. Only *A. umbrosus* shows evidence of a definite periodicity. This is related to rainfall and the presence of water in the jungle swamps. The incidence of malaria in the coastal districts is fairly constant throughout the year, with only a slight rise in October–November. *A. sundaicus* is the vector in the brackish-water zone. It is most abundant in September. It appears to be efficient only when it attacks man in large numbers, relative to the other species.

Msangi (A. S.). **Cetyl Alcohol and larval Mosquito Control.**—*E. Afr. med. J.* **33** no. 9 pp. 353–356, 1 ref. Nairobi, 1956.

An account is given of tests of the possible effects on eggs and larvae of *Anopheles gambiae* Giles, and on the control of the larvae by oil, of cetyl alcohol applied to water at rates similar to, or higher than, those at which it is proposed to use it to reduce evaporation from reservoirs. They indicate that the alcohol would have little or no effect on the hatching of the eggs of mosquitos or the development of the larvae, but would retard the control of the larvae and pupae by oil. This is because the crushing strength of a surface film of the alcohol is much higher than the spreading pressure (about 35 dynes per cm.) of an effective oil. The oil therefore remains in droplets on the film for some time, but it then dissolves it and becomes effective as a larvicide. The delay in action of the oil might give time for it to be carried away on running water or for adults to emerge from some of the pupae in standing water.

Lapage (G.). **Mönnig's Veterinary Helminthology and Entomology.**—4th edn., $9\frac{3}{4} \times 6\frac{1}{2}$ ins., xv + 511 pp., 24 pls., 252 figs., $4\frac{1}{2}$ pp. refs. London, Baillière, Tindall & Cox, 1956. Price £2 2*s*.

This fourth edition (the first by another author) of Mönnig's well-known textbook on parasites of the commoner domestic and fur-bearing animals (and, incidentally, of man) is, like the earlier ones, in four sections, which in the main retain their old form [*cf. R.A.E.*, B **22** 183]. The introductory one dealing with parasitology in general has been rewritten and occupies 20 pages. The section on the technique of collecting and preserving parasites and the methods used in diagnosing their presence, which is also brief, has been slightly enlarged and transferred to the end. Corrections have been made and new matter added as required to the section on helminth parasites, for which notes supplied by Mönnig have been freely used. The chief changes have been made in the section on arthropod parasites (pp. 305–466), in which nomenclature has been modernised and discussions of classification and control have been extended to incorporate the results of recent work. The list of parasites cited under their hosts is retained as before, and a bibliography of some 200 key references is substituted for footnotes.

Výsotskaya (S. O.). **Short Key to Fleas of epidemiological Importance.** [*In Russian.*]—*Opred. Faune SSSR* no. 63, 10½ × 6¾ ins., 100 pp., 207 figs., 45 refs. Moscow, Zool. Inst. Akad. Nauk SSSR, 1956. Price 6 *rub.* 40 *kop.*

This book is in three main sections. The first (pp. 9–34) is a review of the morphology and biology of fleas, their importance as vectors of diseases of man and animals, with particular reference to the theory of natural nidality of transmissible diseases [*cf. R.A.E.*, B **44** 145], and methods of collecting and preserving them, and the second is a key to the 50 genera of fleas that occur in the Soviet Union. The third comprises notes on the characters, distribution, hosts and disease relations of the 20 genera that contain species considered to be of epidemiological importance, and keys to these species. The two sexes are dealt with separately in most of these keys, and indications of the hosts of the species and their distribution in the Union and elsewhere are included. There are also indexes to the fleas and their hosts.

LaForge (F. B.), Green (N.) & Schechter (M. S.). **Allethrin. Synthesis of four Isomers of *cis*-Allethrin.**—*J. org. Chem.* **21** pp. 455–456, 7 refs. Baltimore, Md., 1956.

The following is based on the authors' summary. Allethrin is a mixture of eight possible isomers [*cf. R.A.E.*, B **40** 116–117], of which the four *trans* isomers have been previously described and tested for insecticidal activity [**42** 135]. To complete the series, the four *cis* isomers have now been prepared. These forms are being investigated for relationships between isomerism (optical and geometric) and insecticidal properties [*cf.* **41** 125; **43** 86].

Chams (G.) & Mohsénine (H.). **Un cas de myase ophthalmique par la larve de *Rhinostrus purpureus*.**—*Acta med. iran.* **1** no. 1 pp. 22–26, 1 col. pl., 2 figs., 8 refs. Teheran, 1956.

A case is recorded from Persia of myiasis of the eye caused by larvae of *Rhinoestrus purpureus* (Brauer). Inflammation set in three days after a large fly had settled on the eye of the patient and cleared completely after the larvae, which were then in the second instar, had been removed from the surface of the cornea. The characters of the larvae, on which their identification was based, are described.

Papers noticed by Title only.

Quayle (J. R.). **Paper Chromatography of Pyrethrins and their Derivatives.** —*Nature* **178** no. 4529 pp. 375–376, 1 fig., 9 refs. London, 1956.

Grayson (J. M.) & Cochran (D. G.). **On the Nature of Insect Resistance to Insecticides** [a review article].—*Virginia J. Sci.* (N.S.) **6** no. 3 pp. 134–145, 1 graph, 47 refs. Richmond, Va., 1955.

Gregson (J. D.). **The Ixodoidea of Canada.**—*Publ. Dep. Agric. Can.* no. 930, 92 pp., 1 pl., 219 figs., 7 maps, 5 pp. refs. Ottawa, 1956.

Beroza (M.). **3,4-Methylenedioxyphenoxy Compounds as Synergists for natural and synthetic Pyrethrins.**—*J. agric. Fd Chem.* **4** no. 1 pp. 49–53, 14 refs. Easton, Pa., 1956.

Sesamolin is 2-(3,4-methylenedioxyphenoxy)-6-(3,4-methylenedioxyphenyl)-3,7-dioxabicyclo(3.3.0)octene, so that it differs from sesamin only in having a 3,4-methylenedioxyphenoxy group in place of one of the two 3,4-methylenedioxyphenyl groups of the latter. In view of the marked increase in synergism with pyrethrins produced by this change [*R.A.E.*, B **43** 157], the author synthesised new compounds containing the 3,4-methylenedioxyphenoxy group and tested them as synergists, and he describes the preparation and properties of 66 of them in this paper. In preliminary tests as synergists with pyrethrins and allethrin against house-flies [*Musca domestica* L.] by the turntable method [**26** 246], almost all the ethers, acetals and sulphonates showed synergism, the urethans showed less activity, and the esters of carboxylic acids showed practically none. Some of the compounds were active enough to merit further study.

Beroza (M.). **Determination of Methylenedioxyphenyl-containing Synergists used in Analysis of Fly Sprays.**—*J. agric. Fd Chem.* **4** no. 1 pp. 53–56, 1 graph, 13 refs. Easton, Pa., 1956.

The following is substantially the author's summary. A chromotropic-sulphuric acid method for the determination of methylenedioxyl groups has been applied to the determination of pyrethrum synergists containing these groups. The utility of the method has been demonstrated by its use for the estimation of piperonyl butoxide, sulfoxide [1,2-methylenedioxy-4-(2-(octylsulphinyl)propyl)benzene], piperonyl cyclonene and n-propyl isome [di-n-propyl 6,7-methylenedioxy-3-methyl-1,2,3,4-tetrahydronaphthalene-1,2-dicarboxylate] in fly sprays. It may also be applied to the determination of the synergists in aerosol formulations, and means of overcoming interference caused by several of the more important constituents of these are given.

Howell (D. E.) & Goodhue (L. D.). **Fly Repellents.**—*Soap & chem. Spec.* **31** no. 10 pp. 181, 185, 187, 189, 221, 1 graph, 7 refs. New York, N.Y., 1955.

Some of the main results are given of extensive tests made in Oklahoma over a period of three years to evaluate the repellency to flies of di-n-propyl isocinchomeronate (R-326), 2,3,4,5-bis(Δ^2-butenylene)-tetrahydrofurfural (R-11) and 2,3,4,5-bis(Δ^2-butenylene)-tetrahydrofurfuryl alcohol (R-440), which had previously been shown to be good repellents [*cf. R.A.E.*, B **40** 96; **42** 134] except under adverse weather conditions. In the laboratory tests, repellency to house-flies [*Musca domestica* L.] and stable flies [*Stomoxys calcitrans* (L.)], respectively, was determined by the sandwich and organdie-bag methods described by Goodhue [**42** 133–134]. The effects of weather in the sandwich tests was simulated by exposing the prepared strips to the rays of a sun lamp on a slowly revolving turntable over water. In the field tests, known amounts of repellents were rubbed into the hair of calves, cows were treated daily with 3–10 ml. repellent with a mist sprayer to simulate use in an automatic treadle-operated sprayer, surface areas of various kinds were treated by rubbing or spraying, according to their size, and paper strips were dipped in a 1 per cent. acetone solution of repellent. Of large numbers of chemicals tested in the laboratory as adjuvants to

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prolong the effectiveness of R-326 against *M. domestica*, 14, including Triton X-100, gave good results, and some coumarin derivatives, particularly β-methylumbelliferone, and hydroquinone and some of its derivatives were very effective. In tests against *Stomoxys* in which the repellents or mixtures were applied at 2 gm. per 100 sq. ins. organdie, the periods of effectiveness in days were 4 for R-440, 2 for R-11, 1 for R-326, 3 for MGK-264 (N-octyl-bicycloheptene dicarboximide [*cf.* **40** 53]), 13 for a 1:1 mixture of R-440 and R-326 and for a 1:1:2 mixture of these two repellents and MGK-264, 7 and 8 for similar mixtures of R-11 and R-326 alone and with MGK-264, and 5 and 9 for 1:1 mixtures of R-11 and MGK-264 and of R-440 and MGK-264. Lowering the proportion of R-440 reduced the effective period of mixtures containing it. All mixtures containing R-326 effectively repelled *M. domestica*.

In 1953, R-11 and R-326 were tested under various conditions in the field. R-326 was much the better. The periods in days for which it gave 90 per cent. protection and (in brackets) 50 per cent. protection in the tests that were continued longer were 1 (3) on calves and 3 (5) on iron in sun, and 12 (13) on calves, 23 on iron, 11 on galvanised iron, 67 on wood and 18 (60) on plaster, all in shade. Used to impregnate paper strips, which were hung first in a fly-free room and then for 24 hours in a barn in which flies were numerous, R-11 gave 90 (50) per cent. reduction in fly specks for only 2 (9) days, whereas R-326 gave 90 per cent. for 21 days, when the experiment ended. Applied to porcelain light shades, however, R-11 gave excellent protection against flies and night-flying insects, whereas R-326 was not so effective. R-326 at 1 ml. in 2 ml. alcohol applied daily as a fine mist to cows controlled *M. domestica* and horn flies [*Siphona irritans* (L.)] very well. Control of *Stomoxys calcitrans* was not quite so good, but was improved by the inclusion of 1 ml. R-440. The repellents greatly increase and prolong the effectiveness of oil-base fly-sprays of pyrethrum with a synergist; in one series of tests, a standard spray of pyrethrum and piperonyl butoxide used at 9 ml. per animal gave about 50 per cent. control, but with the addition of one ml. R-326 it gave nearly 100 per cent. In a spray test in pig houses, suspensions of a wettable-powder formulation composed of 25 per cent. R-326, 12·5 per cent. β-methylumbelliferone, 1·5 per cent. Triton X-100 and 61 per cent. Attasorb (clay) applied to walls and ceilings gave good control of *M. domestica* and appeared to be about ten times as effective as R-326 in oil solution, which had been used the year before. Triton X-100 is a good choice as a wetting agent, as it was one of the materials shown to prolong the effectiveness of R-326.

Mahan (J. G.) & Grayson (J. M.). **Morphological Comparisons of resistant and non-resistant Strains of the German Cockroach,** *Blattella germanica* **(L.).**—*Virginia J. Sci.* (N.S.) **7** no. 3 pp. 166–169, 7 refs. Richmond, Va., 1956.

The following is the authors' summary. Morphological comparisons were made between adults from a non-resistant (normal) strain of the German cockroach, *Blattella germanica* (L.) and those from strains resistant to DDT, chlordane, and lindane [γ BHC]. The criteria employed were: total length, width of head, width of pronotum, and length of pronotum. Significant differences between resistant and non-resistant strains were obtained for all comparisons except total length of males and females in the lindane strain and pronotum length of females in the chlordane strain. Males and females from resistant strains were smaller than those from the normal strain [*cf. R.A.E.*, B **43** 24]. No evidence is offered to explain the apparent correlation of resistance and smaller size.

Fales (J. H.) & Bodenstein (O. F.). **Effectiveness of synergized Allethrin and Pyrethrum Sprays against Mosquitoes.**—*J. econ. Ent.* **49** no. 2 pp. 156–158, 14 refs. Menasha, Wis., 1956.

The results are given of tests in which piperonyl butoxide, sulfoxide [1,2-methylenedioxy-4-(2-(octylsulphinyl)propyl)benzene], propyl isome [di-n-propyl 6,7-methylenedioxy-3-methyl-1,2,3,4-tetrahydronaphthalene-1,2-dicarboxylate] and MGK-264 [N-(2-ethylhexyl)bicyclo(2.2.1)-5-heptene-2,3-dicarboximide] were compared as synergists for allethrin and pyrethrins in deodorised-kerosene sprays against *Aëdes aegypti* (L.) and *Anopheles quadrimaculatus* Say. Sprays were used at 3 ml. per Peet-Grady chamber (13·9 ml. per 1,000 cu. ft.). Adults of *Aëdes* were exposed for five minutes and removed from the chamber after it had been ventilated for ten minutes, whereas adults of *Anopheles* were exposed for ten minutes and then removed immediately. Mortality counts were made after one day. The percentages of males and (in brackets) females of *Aëdes* killed by 0·033 and 0·066 mg. pyrethrins per ml. without synergist and by 0·033 mg. pyrethrins with 0·198 mg. piperonyl butoxide, sulfoxide, propyl isome and MGK-264 were 68 (39), 89 (66), 85 (77), 77 (67), 66 (65) and 66 (45). Corresponding figures for 0·264 and 0·528 mg. allethrin without synergist and 0·264 mg. allethrin with 1·584 mg. piperonyl butoxide, sulfoxide, propyl isome and MGK-264 were 61 (47), 83 (71), 75 (63), 75 (59), 68 (61) and 55 (44). The percentages of males and (in brackets) females of *Anopheles* killed by 0·2 and 0·6 mg. pyrethrins alone and by 0·2 mg. with 1·2 mg. piperonyl butoxide, sulfoxide, propyl isome and MGK-264 were 91 (60), 98 (83), 99 (89), 99 (92), 97 (84) and 92 (70). Corresponding figures for 0·4 and 1·2 mg. allethrin alone and 0·4 mg. with 2·4 mg. piperonyl butoxide, sulfoxide, propyl isome and MGK-264 were 97 (65), 99 (84), 96 (78), 99 (78), 99 (84) and 96 (77).

When tested alone at the concentrations at which they were used with pyrethrins, MGK-264 gave 2 and 6 per cent. kill of females of *Aëdes* and *Anopheles*, whereas the three more effective synergists gave no knockdown or kill. The only evidence of synergism by MGK-264 was in the tests against females of *Anopheles*, and it is possible that its action in these tests was additive and not synergistic. It is concluded that the results of tests against mosquitos should be considered in formulating sprays for use against flying insects, as some of the synergists commonly included in such sprays have little or no synergistic effect against mosquitos.

Lofgren (C. S.) & Cutkomp (L. K.). **Toxicity of DDT to the American Cockroach when Lipid Content and Temperature are varied.**—*J. econ. Ent.* **49** no. 2 pp. 167–171, 6 figs., 17 refs. Menasha, Wis., 1956.

It has been shown that DDT is more toxic to various insects, including the American cockroach [*Periplaneta americana* (L.)], at a relatively low post-treatment temperature than at a high one, and that an effect of temperature on the cuticle is not an essential factor in this [*cf. R.A.E.*, A **40** 345–346; B **39** 25; **41** 140; **42** 74, etc.]. The studies described in this paper were undertaken to investigate whether the negative temperature coefficient of DDT injected into *P. americana* was related to the amount of lipids in the cockroach and to obtain more data on the general relationship between quantities of insect lipids and the toxicity of DDT [*cf.* B **42** 71; **43** 115]. The lipid contents of the cockroaches were modified by feeding them for about 80 days on diets of high and low protein content or on a proprietary dog food. These diets had protein contents of 91, 2·5 and 24 per cent., respectively. After the conditioning period, the sexes were separated in each of the diet groups and each batch divided into two, one of which was kept after treatment at 15°C. [59°F.] and the other at 30°C. [86°F.].

Treatment was by injection of acetone solutions of DDT into the abdomen, and mortality was determined at 24-hour intervals for five days.

The LD50's in μg. per gm. body weight for males conditioned on the high-protein and low-protein diets and dog food and kept after treatment at 15 and (in brackets) 30°C. were 0·4 (5·9), 1 (9) and 1·7 (10·5). Corresponding figures for females were 1·2 (21), 3·1 (41) and 5·3 (58). Cockroaches in which DDT produced no symptoms at 30 or 32°C. [89·6°F.] showed typical DDT tremors within a few minutes when the temperature was lowered by as little as 5°C. [9°F.]. The symptoms could be made to disappear by raising the temperature again. Lipid values in percentages on a dry weight basis at the low and (in brackets) high post-treatment temperature were 4·2 (3·8), 9·5 (6·3) and 14·5 (6·6) for males on the high-protein and low-protein diets and dog food and 3·1 (2·8), 11·6 (8·7) and 13·9 (11·2) for females. The differences in lipid values with temperature were unexpected, but might be explained by increased metabolism at the higher temperature. There was no indication that the amount of lipids present might be a factor responsible for the negative temperature coefficient of DDT, and the differences in amounts of lipids in males and females were not sufficient to explain the greater susceptibility of the males.

March (R. B.), Fukuto (T. R.), Metcalf (R. L.) & Maxon (M. G.). **Fate of P^{32}-Labeled Malathion in the Laying Hen, White Mouse, and American Cockroach.**—*J. econ. Ent.* **49** no. 2 pp. 185–195, 1 fig., 13 refs. Menasha, Wis., 1956.

The following is virtually the authors' summary. The fate of ^{32}P-labelled malathion (O,O-dimethyl S-1,2-di(ethoxycarbonyl)ethyl phosphorodithioate) has been extensively studied in the laying hen and, for comparative purposes, in the white mouse and American cockroach (*Periplaneta americana* (L.)). Hens were treated by feeding 100 parts per million ^{32}P-malathion in the mash, by spraying with 0·5 per cent. ^{32}P-malathion water emulsion, and by intraperitoneal injection of doses ranging up to 200 mg. per kg. Residues were determined in the droppings, eggs and various tissues. Mice were treated by intraperitoneal injection and cockroaches by topical application or injection through the mesothoracic spiracle. The experiments also included preparation of expected metabolites of malathion and tests of their toxicity to various arthropods and activity in inhibiting cholinesterase of the housefly [*Musca domestica* L.].

In the experiments with fed hens, 60 per cent. of the consumed malathion was eliminated in the droppings in 2–4 days and 75 per cent. in 5–6 days. Water-soluble metabolites and degradation products formed 97–98 per cent. of the radioactive compounds excreted. The maximum total residues found in any of the tissues or eggs examined were less than 3 per cent. of the concentration being fed. These residues decreased after the hens were removed from the radioactive feed.

In the case of the sprayed hens, the largest concentration of radioactivity was excreted in the droppings in the first 24 hours after treatment, the amount decreasing throughout the remainder of the experiment. The maximum concentration in the droppings was only about half that in the droppings of the fed hens. Less than 12 per cent. of the applied dose was absorbed and eliminated in 32 days; this suggests that malathion is poorly absorbed through the skin and unavailable for absorption from the feathers. About 90 per cent. of the compounds excreted was in the form of water-soluble metabolites and degradation products. The residues in tissues and eggs were approximately one-tenth of those found in the experiments with fed hens.

When a massive dose was injected intraperitoneally into a hen, more than 50 per cent. was eliminated in three hours, and nearly the entire dose in 24 hours. During the period of greatest elimination, 1–3 hours after injection, nearly twice as much radioactivity was eliminated as unchanged malathion and chloroform-soluble metabolites as was eliminated as water-soluble metabolites and degradation products. At other times, 90 per cent. or more was excreted as water-soluble metabolites and degradation products. No gross toxic effects were noted in either the fed or the sprayed hens, and those treated by injection were not prostrated or killed, though they showed definite initial symptoms of poisoning.

The metabolism of malathion in the laying hen and white mouse is complex, probably involving progressive hydrolysis of the ethyl ester moieties to produce more ionic and water-soluble compounds, which apparently exhibit a low order of toxicity. It probably involves, as well, the oxidation of the thiono-sulphur moiety to produce a series of phosphorothiolates. One of these may be O,O-dimethyl S-1,2-di(ethoxycarbonyl)ethyl phosphorothiolate, which was the only metabolite tested that showed anticholinesterase activity and toxicity markedly greater than those of malathion.

The metabolism of malathion in the cockroach is apparently less extensive and complex than it is in warm-blooded animals. The less effective metabolism in the insect may explain why malathion is much more toxic to insects than to warm-blooded animals, in which most of the rapidly formed metabolites are apparently of a low order of toxicity.

Brydon (H. W.). **The Clear Lake Gnat and its Control in Clear Lake, California during 1954.**—*J. econ. Ent.* **49** no. 2 pp. 206–209, 3 figs., 9 refs. Menasha, Wis., 1956.

Clear Lake, California, was treated with 14,000 U.S. gals. of a DDD (TDE) formulation in September 1949 for the control of *Chaoborus astictopus* D. & S. [*R.A.E.*, B **39** 185], and no larvae of this species were found in it for almost two years. Some were collected in July 1951, however, and the population steadily increased from that time until the popularity of the area as a resort was again affected. Surveys made at least once a month from March to September 1954 showed that the larvae were present in every part of the lake regardless of depth, and the population density did not vary appreciably with the depth of the water [*cf.* **32** 185]. They were also present in farm ponds right to the edges, where the water was only 1–2 ins. deep. Light-traps were operated weekly from 1st March, and adults were caught from 7th May onwards. When the adult population was high, the larval population was low, and conversely. A control operation with procedure closely following that adopted in 1949 was carried out on 25th and 26th September. An emulsified solution of DDD was dispensed in 700-ft. swathes from barges to make a DDD concentration of about 1:50 million in the lake water. It was estimated that 60 per cent. of the larvae were eliminated by the third day, 99·99 per cent. by the 13th day and all in 40 days. A large Chironomid breeding in the lake was also controlled, but more slowly. Plankton, oligochaetes and fish were apparently unaffected. During the winter months, all other lakes, sloughs and ponds around Clear Lake in which *C. astictopus* might breed were also treated. Control in ponds was at first unsatisfactory, probably because the cold weather reduced the nocturnal activity of the larvae, and they had to be treated two or three times. The area cleared was extended as far as possible before the spring. June and July 1955 passed without any adults being seen.

Siakotos (A. N.). **Contamination of Food and Air by Lindane Vapor.**—*J. econ. Ent.* **49** no. 2 pp. 212–214, 6 refs. Menasha, Wis., 1956.

An account is given of experiments in which packaged or unpackaged food stored in rooms that had been treated with γ BHC (lindane) was contaminated by the vapours from the BHC deposits. The food used was shredded wheat, which was selected because its surface area is high and it is relatively free from solvent matter. The BHC was applied in comparable amounts by fumigation (vaporisation), by spraying surfaces with an emulsified solution, and by painting surfaces with a solution in oil. The food samples and air were analysed for BHC after the samples had been stored in the rooms for two hours including the treatment period, or for 26 hours, 1 week or 2 weeks beginning after treatment was completed. The fumigated rooms were aired for 30 minutes at the end of two hours, but the other rooms were kept closed.

The amounts of BHC in air and food samples both decreased with time, and those in the air were highest in the fumigated rooms and lowest in that treated with the oil solution. Contamination of the food samples during treatment was greatest in the fumigated rooms, but post-treatment contamination was greatest in the room treated with oil solution. It is thought that the application of BHC in oil may lead to a more cumulative contamination than the other methods through the solvent effect of the oil, which also vaporises, in a food that is practically without solvent material.

The concentrations of BHC in air indicated that the rate of volatilisation was greatest for the deposit applied by fumigation and least for that applied in oil solution. Higher vapour concentrations led to higher food sorption, and a decrease in vapour concentration to a reduction in the amount of BHC sorbed. This reduction was probably due to revaporisation of some of the initially adsorbed BHC and to reduced adsorption. If the product had an appreciable fat content, absorption might also be concerned in the complex.

Peffly (R. L.) & Labrecque (G. C.). **Marking and Trapping Studies on Dispersal and Abundance of Egyptian House Flies.**—*J. econ. Ent.* **49** no. 2 pp. 214–217, 4 refs. Menasha, Wis., 1956.

The following is mainly based on the authors' summary. A study was made in 1953 with traps and marked flies to obtain information on the dispersal of house-flies from an Egyptian village (Tersa) in which they were somewhat resistant to γ BHC (lindane) to other villages in the immediate neighbourhood. A spray of 6 per cent. phenolphthalein in acetone was used to mark 44,000 flies, 94 and 5 per cent. of a sample of which were *Musca domestica vicina* Macq. and *M. sorbens sorbens* Wied. Two traps baited with fish were set in each of six villages within 1½ miles of Tersa. Marked flies were detected by immersing collected flies in a 1 per cent. solution of sodium hydroxide. Of the 210 marked flies recovered in the six villages, 70 per cent. were caught within the first three days, and 81 per cent. were collected in the three villages that were not more than a mile from Tersa. Marked flies apparently did not disperse entirely by flight, but probably partly by being transported on passing people and animals. It is thought that resistant flies did not migrate in sufficient numbers to affect the resistance of the strains in the villages from which they were recovered.

In another test, 10,000 marked flies, principally *M. d. vicina* and *M. s. sorbens*, were released in Sharawi, one of the six villages, and the relationship of the total catch to the catch of marked flies on the first day after release in 12 fish-baited traps distributed through the village was determined. From this, it was estimated that the total house-fly population in Sharawi was

0·75–1 million. Trapping was continued for 15 additional days to obtain further information. Marked flies were caught daily until the 12th day, and one was taken on the 16th day. In all, 7·15 per cent. of the marked flies were recovered, about half of them after the first day.

GRESSETTE jr. (F. R.) & GOODWIN (W. J.). **Cattle Louse Control with treated Rubbing Devices and their Distribution in South Carolina.**—*J. econ. Ent.* **49** no. 2 pp. 236–239, 4 refs. Menasha, Wis., 1956.

Tests were carried out in South Carolina during the winter of 1954–55 on the control of cattle lice with rubbing devices. The loose-cabled fly-type [*R.A.E.*, B **40** 131], a tight-cabled louse-type [**43** 118] and a commercial type of rubbing device were used. The commercial type resembles the louse-type except that there is only one cable, which is extended through a pulley and has a 30–40 lb. weight at the end to keep it stretched. The materials tested, all of which were emulsion concentrates mixed with fuel oil, and (in brackets) the concentrations at which they were used included chlordane (2 and 5 per cent.), DDT (5 per cent.), γ BHC (lindane) (0·5 per cent.), malathion (2 per cent.), and two proprietary mixtures (5 per cent.). One of the latter contains 25 per cent. butoxypolypropylene glycol, 25 per cent. DDT and 0·15 per cent. γBHC, and the other contains 1·2 per cent. piperonyl butoxide, 0·35 per cent. rotenone and 0·15 per cent. pyrethrins. Each device was first treated with 1 U.S. gal. insecticide in November and subsequently with ½ U.S. gal. every 2–3 weeks. All the materials gave excellent control provided that the cattle had access to the rubbing units early in the season before the louse populations had begun to increase. No ill effects from the oil with which the insecticides were mixed was noticed on the animals' skins, and the use of units treated with 2 per cent. malathion appeared to have no effect on the cholinesterase activity of the cattle. All the devices gave excellent results, but the home-made ones are more economical. Using the treated devices for four months cost only one-third as much as making two applications of spray.

Solenopotes capillatus End. and *Damalinia* (*Bovicola*) *bovis* (L.) were abundant on cattle in South Carolina in 1954–55, *Linognathus vituli* (L.) was found in small numbers throughout the State and *Haematopinus eurysternus* (Nitzsch) was seen occasionally.

EARLE jr. (H. H.). **Automatic Device for the Collection of Aquatic Specimens.**—*J. econ. Ent.* **49** no. 2 pp. 261–262, 1 fig. Menasha, Wis., 1956.

A device referred to as ADCAS (automatic device for the collection of aquatic specimens) was designed in 1954 to provide a rapid and reliable method of collecting eggs, larvae and pupae of mosquitos from successive dip samples taken in routine surveys. It is housed in a metal cylinder, 6 ins. in diameter and 7 ins. high and is composed of a metal funnel of which the larger end is soldered to the top of the cylinder and the smaller end into the metal cap of a 120-cc. bottle. Two openings in the side of the funnel are covered with 96-mesh stainless-steel cloth soldered into place, and a third accommodates a copper-tube siphon which is soldered into place at this junction. The intake end of the siphon is in the bottle and is covered with a detachable strainer of the stainless-steel cloth. A coarse strainer is clipped over the mouth of the funnel. When a dipped sample is poured into the funnel, débris is retained by the coarse strainer, excess water escapes through the openings in the side of the funnel and the rest fills the bottle

and starts the operation of the siphon. Mosquito eggs, larvae and pupae are retained by the steel-cloth strainer over the inlet of the siphon, which half empties the bottle so that it is ready for the next sample. When sampling at a station is complete, the collecting bottle with its specimens is removed, labelled and sealed, and an empty one is attached. Field tests in which four experienced collectors, working by the traditional method, passed through the device water from which they had removed all the immature stages they could find showed that an average of 12 per cent. of the larvae and pupae were being thrown away by the old method, which was also much slower.

Caldwell jr. (A. H.). **Dry Ice as an Insect Anesthetic.**— *J. econ. Ent.* **49** no. 2 pp. 264–265, 1 ref. Menasha, Wis., 1956.

A description is given of an inexpensive and convenient method of anaesthetising insects, particularly house-flies [*Musca domestica* L.] for topical treatment with an insecticide, by using dry ice to produce carbon-dioxide gas. A container of 5 U.S. gals. capacity was sunk into a hole in a table so that the top was flush with the table. A removable 16-mesh screen could be supported in it 2 ins. below the top. A metal can 2 ins. in diameter that was lined with corrugated cardboard for insulation and would hold a small cylindrical basket was similarly sunk in the table, and dry ice was put in this can to half its capacity. The large container was charged with 5 lb. crushed dry ice. A high concentration of the gas was built up in it in five minutes in a warm room, and generation of the gas continued for about six hours.

About 400 flies were lowered into the container in a cage and were all knocked down within one minute. The cage was then removed, the screen was placed in the container, and the flies were dumped on it. The females were sorted out and put in one of the small baskets or arranged for immediate topical treatment by placing them in the grooves of a piece of corrugated cardboard so that the same side was uppermost. The basket or cardboard rested on the large screen during the process, but when the basket was used, it was then put in the small container. After they had been treated, flies were transferred to recovery cages. When these were in a room with a temperature of more than 70°F., flies exposed for up to 5, 30 and 60 minutes recovered in 1–2, 3–5 and 5–10 minutes, respectively.

Whitlaw jr. (J. T.), Bickley (W. E.) & Cory (E. N.). **Mosquitoes in Farm Ponds in Maryland.**—*J. econ. Ent.* **49** no. 2 p. 273. Menasha, Wis., 1956.

The number of farm ponds in Maryland has increased in recent years, and five counties were surveyed in 1955 to determine whether they are an important source of mosquitos. The 55 ponds examined ranged from 0·5 to 5 acres in size and were 1–10 years old. All were visited in June or early July and 30 of them again in August. Larvae were found in nine at the first visit and three at the second. The average number per dip in positive ponds ranged from 0·014 to 10. There was no evident correlation between the presence of larvae and the amount of vegetation or age or size of the pond, but the larvae were absent or very scarce in ponds containing fish. The larvae collected were mainly of species that do not readily bite man; *Culex pipiens* L. was the only one considered an important pest mosquito in Maryland and it was found in only one pond.

Hansens (E. J.). **Chlordane-resistant Brown Dog Ticks and their Control.** —*J. econ. Ent.* **49** no. 2 pp. 281–283. Menasha, Wis., 1956.

Deposits from sprays containing 2 per cent. chlordane applied 3–12 times a year had kept *Rhipicephalus sanguineus* (Latr.) successfully under control in the buildings of a large kennel in northern New Jersey from 1948 to early 1955, but a serious infestation had developed on the dogs in July 1955, and three applications of 3 per cent. chlordane in one week and dipping dogs in 2 per cent. chlordane failed to control it. Mortality among ticks collected from the dogs and kept in closed test tubes lined with filter paper impregnated with chlordane was not complete until the fifth day, by which time 75 per cent. were dead or moribund in an untreated control tube. Malathion, used at 1 and 2 per cent. as a spray for buildings or at 1 per cent. as a dip for dogs gave only partial control of the ticks, and dusting dogs with 4 per cent. malathion or 1 per cent. γ BHC (lindane) was virtually ineffective. However, γ BHC killed nearly all ticks when used at 0·25 or 0·5 per cent. as a spray for the buildings or at 0·045 per cent. as a dip, and general adoption of these treatments practically eliminated the infestation by early September. When the stronger BHC spray was used, dogs were not returned to the building for three days as a precaution.

Blum (M. S.) & Kearns (C. W.). **The Effect of Pyrethrum Activators on the Toxicity of Sabadilla to House Flies.**—*J. econ. Ent.* **49** no. 2 p. 283, 7 refs. Menasha, Wis., 1956.

The results are given of studies on the ability of six pyrethrum synergists to increase the toxicity of sabadilla to house-flies [*Musca domestica* L.]. The synergists are piperonyl butoxide, piperonyl cyclonene, sulfoxide [1,2-methylenedioxy-4-(2-(octylsulphinyl)propyl)benzene], MGK-264 [N-(2-ethylhexyl)bicyclo(2.2.1)-5-heptene-2,3-dicarboximide], IN. 930 [N-isobutylundecyleneamide] and n-propyl isome [di-n-propyl 6,7-methylenedioxy-3-methyl-1,2,3,4-tetrahydronaphthalene-1,2-dicarboxylate]. The percentages of female house-flies killed in 24 hours by 0·5 or (in brackets) 1 μg. sabadilla extract applied topically without application of synergist and immediately after application of 5 (or 10) μg. piperonyl butoxide, piperonyl cyclonene, sulfoxide, MGK-264, IN. 930 and n-propyl isome were, respectively, 8 (19), 50 (77), 32 (56), 48 (72), 14 (53), 19 (52) and 38 (52).

Lewis (D. J.). **Calliphoridae of medical Interest in the Sudan (Diptera).**—*Bull. Soc. ent. Égypte* **39** pp. 275–296, 6 maps, 64 refs. Cairo, 1955.

Records are given of the distribution in the Sudan of nearly 50 Sarcophagids and Calliphorids known to occur there, and notes are included on the habits of some, particularly *Wohlfahrtia nuba* (Wied.), which sometimes infests wounds in man and domestic animals, chiefly camels, and *Chrysomyia putoria* (Wied.), which breeds in large numbers in pit latrines. Attention is also drawn to some morphological differences between *C. putoria* and *C. albiceps* (Wied.). There are very short sections on flies that breed in carrion, those that cause myiasis and those found to be attracted to malodorous plants. A list is given of the species that bred in the carcasses of guineapigs exposed at Wad Medani during 1945–46; those that did so frequently were *C. albiceps*, *W. nuba* and *Sarcophaga* spp. Flies causing myiasis are of minor importance in the Sudan apart from *Auchmeromyia luteola* (F.) and *Cordylobia anthropophaga* Grünb.

Fairbairn (H.) & Watson (H. J. C.). **The Transmission of** *Trypanosoma vivax* **by** *Glossina palpalis*.—*Ann. trop. Med. Parasit.* **49** no. 3 pp. 250–259, 3 graphs, 15 refs. Liverpool, 1955.

The following is partly based on the authors' summary. In an investigation in Nigeria into the causes of an increase in the percentage of *Glossina palpalis* (R.-D.) infected with *Trypanosoma vivax* during the rainy season, infection rates were found to be correlated with temperature and with the mean length of the trypanosomes on which the flies had fed. In adults of *G. palpalis* that had emerged from pupae kept at 24–26°C. [75·2–78·8°F.] and (in brackets) at 28–29°C. [82·4–84·2°F.] and had fed on a sheep infected with *T. vivax*, infection rates (percentages of flies with crithidia or trypanosomes in the hypopharynx among those that survive for 13–15 days) were 47·59 (70·83), 39·04 (65·05), 33·16 (65) and 11·11 (50) in flies maintained at 23°C. [73·4°F.], 24–26, 28–29 and 30°C. [86°F.], respectively. The differences in infection rates between flies from pupae kept at 24–26 and 28–29°C. were significant at each maintenance temperature, and the successive reductions in infection rate with each increase in maintenance temperature were significant between maintenance temperatures of 23, 28–29 and 30°C. for the flies from pupae kept at 24–26° but not for those from pupae kept at 28–29°. The survival rates of the flies were significantly lower at 28–29°C. or 30°C. than at 23°C. or 24–26°C.. The infection rates in flies that had emerged from pupae kept at 23°C. were 0 and 34·62 at maintenance temperatures of 23 and 24–26°C., respectively, and the rate in flies that had emerged from pupae kept at 30°C. and were subsequently maintained at 23–30°C. was 19·23. Male and female flies were equally infected in each temperature group. In flies that had emerged from pupae kept at 24–26°C. and had subsequently been maintained at 23°C. or at 24–26°C., there was a significant correlation between the mean length of the trypanosomes taken up in the blood-meals and the subsequent infection rate. For the laboratory transmission of *T. vivax* by *G. palpalis*, it is recommended that the pupae should be incubated at 28°C. and the flies maintained at 23°C. This gives the highest rates of infection and survival, and the development cycle of the trypanosome should be 12–13 days or less [*cf. R.A.E.*, B **45** 21]. If a quick cycle is desired, the flies should be kept at 28°C.

Duke (B. O. L.). **Studies on the Biting Habits of** *Chrysops*. **II. The Effect of Wood Fires on the Biting Density of** *Chrysops silacea* **in the Rain-forest at Kumba, British Cameroons.**—*Ann. trop. Med. Parasit.* **49** no. 3 pp. 260–272, 3 graphs, 5 refs. Liverpool, 1955.

Smoke is believed to repel most insects, but fly-boys collecting *Chrysops silacea* Aust. in the rain-forest at Kumba, British Cameroons, habitually light wood fires to increase the catch, and preliminary investigations confirmed that a fire considerably increases the number of flies taken at ground level. In this second paper on studies on the biting habits of *Chrysops* [*cf. R.A.E.*, B **45** 21], an account is given of investigations made to determine the extent to which biting density is increased by a wood fire, the factors responsible for the increase, and the effect of the fire on the biting cycle. Catches were made by one man at a time from 7 a.m. to 7 p.m. without fire on nine days and with fire on nine others in April and May 1954, at each of four stations on the forest floor. At the end of each hour, the number of flies caught during that hour was recorded and readings were taken of the wet- and dry-bulb thermometers. At a later date, as a further comparison, 21 complete days' catching with a fire was carried out at another ground

station at the bottom of a forest gully where the hourly biting densities of *C. silacea* were known from the results of 29 days' catching in a previous experiment [**45** 22].

The presence of a fire increased biting density at ground level by more than six times for the day as a whole. The relative increase was most marked during the morning, when catches on the forest floor are normally small, but was still considerable in the afternoon. There was a marked resemblance between curves for hourly catches attributable to fire alone and the normal curve for catches at canopy level [*loc. cit.*]. All showed a relatively rapid rise to a peak in the morning, followed by a dip about midday and a second, usually less prominent, peak in the afternoon. Fires burning above the canopy at 130 ft. and in the canopy at 92 ft. exerted no effect on catches there, but a fire at 28 ft. had almost as much effect as one at ground level. The attractiveness of the fire for flies above it did not appear to be attributable to an increase in temperature or saturation deficiency, which remained below the thresholds necessary to activate the flies at ground level. Experiments with a pale blue banner and with kerosene stoves showed that the visual stimulus of wood smoke and the heat played no part in attracting the flies to fires, but comparison of wood fires and fires of oil and rope with and without the addition of dead leaves led to the conclusion that the characteristic smell of wood smoke was the attractant responsible.

Willett (K. C.) & Fairbairn (H.). **The Tinde Experiment: a Study of *Trypanosoma rhodesiense* during eighteen Years of cyclical Transmission.**—*Ann. trop. Med. Parasit.* **49** no. 3 pp. 278–292, 7 figs., 14 refs. Liverpool, 1955.

It has been suggested that *Trypanosoma rhodesiense* is a variant of *T. brucci* that has acquired the ability to infect man and would lose this ability and revert to *T. brucei* if it were passaged cyclically by *Glossina* through animals [*cf. R.A.E.*, B **18** 174, 264, etc.]. In experiments to test this hypothesis, begun at Tinde in 1934, a line of *T. rhodesiense* originally transmitted from man to sheep by *Glossina morsitans* Westw. [**24** 217] was passaged cyclically by *G. morsitans* through 115 sheep over a period of 18½ years. The infectivity of the strain to man was tested periodically. In addition, three branch lines were similarly passaged, one during 1936–48 in antelopes, one during 1940–47 in monkeys (*Cercopithecus aethiops*) and one during 1946–50 in sheep infested with the monkey line. An account of the work up to 1945 was published by Fairbairn & Burtt [**37** 196]. In this paper, the results obtained since 1945 are given, and, for many aspects of the work, the findings from 1934 to 1953 are integrated.

The main sheep line did not lose its infectivity to man at any time during the 18½ years, but the infectivity fluctuated in an apparently cyclical manner over the period 1940–53 with a maximum of 93 per cent. of men bitten becoming infected in 1945 and minima of 11 per cent. in 1940 and 20 per cent. in 1951. The incubation period in man, on the other hand, tended to increase steadily and nearly doubled in 17 years, indicating a decreasing virulence for man. Virulence of the line for sheep, assessed by mean length of life after first exposure to infected bite, also showed a general progressive decline, but fluctuated in inverse proportion to its infectivity to man 1–2 years later. No sheep recovered spontaneously from the infection. Infectivity to man of the antelope line fluctuated greatly but had not been lost in 1946, the last year in which it was tested. Six annual tests (1941–46) gave no evidence of fluctuation in the infectivity for man of the monkey line other than that attributable to random sampling. Its virulence to the

monkeys increased steadily throughout 1940–46. The length of its fly cycle had increased in 1946, its transmissibility had decreased, and it was lost in 1947 owing to failure to obtain transmission. The line returned from monkeys to sheep in 1946 was highly virulent to them at first, but its virulence decreased rapidly and resembled that of the main sheep line in 1947–49. Its infectivity to man, tested in 1948 and 1949, was also similar.

A number of cases of resistance to infection in the monkeys and the results of reinfection of these animals are recorded.

Gillies (M. T.). **The pre-gravid Phase of ovarian Development in** *Anopheles funestus*.—*Ann. trop. Med. Parasit.* **49** no. 3 pp. 320–325, 2 figs., 5 refs. Liverpool, 1955.

In the course of work on age-groups in populations of *Anopheles gambiae* Giles in a low-lying coastal area of Tanganyika [*R.A.E.*, B **43** 71], exactly similar observations were made on ovarian development in natural populations of *A. funestus* Giles. It was found that the pre-gravid rate (percentage of fed females that would require another blood-meal for maturation of the ovaries) was 20·7. Among the pre-gravid group, 34·5 per cent. were unfertilised, and 73–80 per cent. of those fertilised were nulliparae. Most of the pre-gravid females were therefore newly emerged. It is concluded that a pre-gravid phase of development, in which the ovaries do not advance beyond Christophers' stage II [**29** 93], follows the first blood-meal in newly emerged females of *A. funestus*. Though the composition of the pre-gravid group differed in certain respects from that previously found in *A. gambiae*, in that the percentages of fertilised females and of females that had oviposited were, respectively, 65·5 and 13–17·5 in *funestus* and 26·1 and 7·5–9 in *gambiae*, it is evident that the pre-gravid rate will only slightly overestimate the newly emerged element in wild populations of either species. Comparison of monthly variation in the pre-gravid rate with the total numbers of females caught biting in an experimental hut indicates that the age composition of populations of *A. funestus* is much more stable than that of populations of *A. gambiae* [*cf.* **43** 72] as would be expected in view of the semi-permanent nature of the breeding places of *A. funestus*.

Newton (W. L.) & Wright (W. H.). **The Occurrence of a Dog Filariid other than** *Dirofilaria immitis* **in the United States.**—*J. Parasit.* **42** no. 3 pp. 246–258, 8 figs., 19 refs. Lancaster, Pa., 1956.

It has generally been assumed that microfilariae found in dogs in the United States are *Dirofilaria immitis*. However, some from the peripheral blood of dogs obtained from Virginia, Maryland, Pennsylvania and New Jersey in 1954 or 1955 were found to differ from those of *D. immitis* in that, after treatment with formalin and methylene blue, they were shorter and considerably narrower, and the position of various anatomical structures differed in Giemsa-stained thick films. All infections seen with the unknown species were light. Both types showed slight periodicity, but concentrations of the large microfilariae (*D. immitis*) in the peripheral blood were highest at night, whereas those of the small ones were lowest.

Of 71 fleas from four dogs harbouring the small microfilariae, 17 contained fully developed infective-type third-stage larvae in the body cavity and many others had larvae in earlier stages of development. Positives and negatives were found among both *Ctenocephalides canis* (Curt.) and *C. felis* (Bch.) and among both male and female fleas. No fleas out of 23 from dogs harbouring *D. immitis* contained developing larvae. Of 55 females of *Anopheles quadrimaculatus* Say that survived 10–14 days after feeding on

two dogs with large microfilariae, 48 contained second- and third-stage and infective larvae. Some contained as many as 40 such larvae, several of which were in the head and proboscis. Development took place in the Malpighian tubules. Of 117 females that survived for the same time after feeding on three dogs with small microfilariae, none was positive.

No adult worm was recovered from the heart or from the peritoneal areas of dogs harbouring the small microfilariae, but the size of the latter suggests that the species may be *Dipetalonema reconditum*, which is said to be a tissue filaria and was found by Grassi & Calandruccio to develop in fleas [*cf. R.A.E.*, B **44** 7–8]. It is concluded that records of the development in fleas of *Dirofilaria immitis* [*cf.* **44** 7, etc.] may have been due to misidentification of the microfilariae.

It is recorded in an addendum that five adult filariids (one male and four females) were subsequently recovered from the subcutaneous tissues of a dog that harboured microfilariae of the small type. Microfilariae liberated by the females in the fixing fluid were similar to those occurring in the blood. Preliminary observations on the adults indicated that they belonged to a species of *Dipetalonema*.

Williams (R. W.). **The Biting Midges of the Genus *Culicoides* found in the Bermuda Islands (Diptera, Heleidae). I. A Description of *C. bermudensis* n. sp. with a Key to the local Fauna.**—*J. Parasit.* **42** no. 3 pp. 297–300, 3 figs., 2 refs. Lancaster, Pa., 1956. **II. A Study of their Breeding Habitats and geographical Distribution.**—*T. c.* pp. 300–305, 1 map, 9 refs.

The species of *Culicoides* found during an initial survey of the Bermuda Islands in June–July 1955 were *C. crepuscularis* Mall., *C. floridensis* Beck. and one described in the first part of this paper from females only as *C. bermudensis*, sp. n. [*cf.* next abstract]. A key is given to the adults of the three species. An account of the survey is given in the second part; it was carried out by exposing recovery cages over possible breeding places in 15 areas distributed in the nine parishes and a light-trap in eight areas. *C. floridensis* was taken only in the light-trap at one locality. Data are given on the breeding habitats of the other two, and differences in their geographical distribution are noted. *C. crepuscularis* is a pest of man in some areas of the United States, but was not sufficiently plentiful on the Bermuda Islands during the summer of 1955 to be a great nuisance. The host preferences of the other species, which were even less numerous, are not known.

Beck (E. C.). **A new Species of *Culicoides* from Florida with additional Distribution Data for the Genus (Diptera: Heleidae).**—*Florida Ent.* **39** no. 3 pp. 133–138, 2 figs., 6 refs. Gainesville, Fla., 1956.

All but two of the 27 species of *Culicoides* now known to occur in Florida, a list of which is given, were found in an examination of catches from light-traps of the State Board of Health. These catches included one previously undescribed species (*C. knowltoni*, sp. n.) and four other species new to the State. Descriptions are given of the male genitalia and female of the new species and the male genitalia of *C. bermudensis* Williams, which was described from females from Bermuda [see preceding abstract] and was taken in Florida during July and August 1955. Differences between the Bermuda and Florida females of the latter are noted. New records of the distribution in Florida of many of the other species are also given.

Bradbury (F. R.) & Standen (H.). **Benzene Hexachloride Metabolism in *Anopheles gambiae*.—*Nature* 178** no. 4541 pp. 1053–1054, 4 refs. London, 1956.

The absorption and metabolism of BHC was examined in two laboratory strains of *Anopheles gambiae* Giles, of which one (R) was 26 times as resistant to γ BHC as the other (S) [*R.A.E.*, B **45** 68]. Deposits of the α or γ isomer of BHC labelled with ^{14}C were made from carbon-tetrachloride solution in flasks, and weighed batches of mosquitos (50–100 of mixed sex) were exposed in the stoppered flasks at 25°C. [77°F.] for 24 hours with pieces of untreated filter paper for them to rest on. The radioactive material was then recovered and estimated as fractions soluble in carbon tetrachloride and in water. The α isomer was included as it is known that γ-resistant flies [*Musca domestica* L.] can metabolise it as easily as the γ isomer [**45** 30] and it allows of longer survival of the S strain. The results, which are given in a table, show that the R strain absorbs as much BHC as the S strain and converts a smaller proportion (about 6 as compared with 11 per cent. in the case of the γ isomer) to water-soluble products. The radioactivity in the carbon-tetrachloride extracts was shown to be almost all unchanged BHC. As the S strain was knocked down by γ BHC after some 30 minutes and the R strain only after about three hours, a further experiment was carried out in which the mosquitos were exposed to γ BHC for one hour and were then kept for 24 hours at 25°C. in a clean flask. The pattern of absorption and metabolism was very similar to that shown with the longer exposure. Thus, insecticide resistance can occur in a strain of insects that is no more able to metabolise the poison than is a susceptible strain. *A. gambiae* can convert only 11 per cent. or less of absorbed γ BHC to excretable products, whereas house-flies of a resistant strain under similar conditions can convert more than 90 per cent. [**45** 30].

Service (M. W.). **Crossing of two allopatric Populations of *Culex fatigans* Wiedemann.—*Nature* 178** no. 4541 p. 1065. London, 1956.

The pupae and adults of a strain of *Culex pipiens fatigans* Wied. from Lagos, Nigeria, and one from British Guiana were found to be morphologically identical, as were the fourth-instar larvae except for the presence of black tips on the anal papillae of those from British Guiana. Larvae of the two strains had the same survival threshold (9/1,000) when subjected to a salinity test with sodium chloride. Some 80 per cent. of the larvae of the F_1 generation and all of those of the F_2 generation derived from crossing Guiana females with Lagos males had black-tipped anal papillae, but none of those derived from the reciprocal cross had them in either the F_1 or F_2 generation. On further inbreeding, the character of black tips disappeared and remained absent.

Kartman (L.). **Notes on the Encapsulation of *Dirofilaria immitis* in the Mosquito *Aëdes aegypti*.—*Amer. J. vet. Res.* 17** no. 65 pp. 810–812, 1 graph, 3 refs. Chicago, Ill., 1956.

It was observed during work already noticed [*R.A.E.*, B **43** 33] that encapsulation of *Dirofilaria immitis* occurred more frequently in *Aëdes aegypti* (L.) than in *Anopheles quadrimaculatus* Say, and did not occur at all in *Culex pipiens fatigans* Wied. (*quinquefasciatus*, auct.). It appeared to be of little quantitative importance in the extrinsic cycle of the parasite, but more detailed data on its occurrence in *Aëdes aegypti* are given in the present paper. Females that had fed on the infected dog were kept at

about 27°C. [80·6°F.] and a relative humidity of about 80–90 per cent. and provided with sliced apple for food. Some were dissected each day for 20 days. A minority of the microfilariae and rarely a few "sausage stage" larvae were partly or completely encapsulated in 87 of the 229 females dissected throughout the period. The great majority of the encapsulated parasites were in the Malpighian tubules. Encapsulation was first observed on the third day, and the percentage of females with encapsulated filariae, the percentage of filariae encapsulated and the percentage completely encapsulated all increased with time. Most of the microfilariae in *A. aegypti* remained virtually unchanged for the 20 days. Whether this favoured encapsulation is not known.

Bohart (R. M.). **Insects of Micronesia. Vol. 12 no. 1. Diptera: Culicidae.**—pp. [3+] 1–85, 14 figs., 1 map. Honolulu, Bishop Mus., 1957.

This volume forms part of a series on the arthropods of Micronesia [*cf.* *R.A.E.*, A **43** 345]. The area concerned includes the islands of the Mariana, Caroline, Marshall, Gilbert, Bonin and Volcano groups, and also Ocean, Nauru, Wake and Marcus Islands. All but three of the mosquitos recorded belong to the genera *Aëdes* and *Culex*. Of the 42 named species of these genera (one of which is represented by two subspecies), 28 are seen from a distributional list to be confined to the area and most of these to particular island groups. Keys are given to the adults of all the species and to the male genitalia, larvae and pupae where possible. Each species is then described, 13 of them as new, from both sexes, larva and pupa wherever possible, and synonyms are given, together with notes on distribution, habits, ecology and importance as a pest or disease vector, if any. The principal mosquito-borne diseases have been dengue, primarily as a war-time scourge, and Japanese B encephalitis, an outbreak of which occurred on Guam in 1947 [*cf.* **41** 189]. A rather benign type of filariasis [caused by *Wuchereria bancrofti*] is believed to be transmitted by *Culex pipiens fatigans* Wied. (*C. quinquefasciatus*, auct.) and, on Truk, by *C. annulirostris* Skuse.

Smith (A.). **The Attractiveness of an Adult and Child to** *A. gambiae*.—*E. Afr. med. J.* **33** no. 10 pp. 409–410, 2 refs. Nairobi, 1956.

The fact that the incidence of infection with bancroftial filariasis [*Wuchereria bancrofti*] is considerably less in children than in adults may be attributable to a difference in the frequency with which people of different ages are bitten by infected mosquitos [*R.A.E.*, B **43** 47–48]. Biting rates might depend on the amount of protective clothing, and on this basis the inhabitants of Ukara Island [*cf.* **44** 1, etc.] are most exposed to night attack by *Anopheles gambiae* Giles and *A. funestus* Giles between the ages of 6 and 16, when they sleep with little or no covering. An experiment there is described in which direct comparison was made of the attractiveness to *A. gambiae* of a man 38 years of age and a boy of ten. Over four nights, the numbers of females that were caught on the back of the man and of the boy per hour were 23 and 25, respectively. The numbers per sq. ft. of skin exposed were 14·1 on the man and 32 on the boy. It might thus appear that the skin of the boy was twice as attractive as that of the man or that the volume of air over which the attraction operated was independent of the size of the bait.

Crosskey (R. W.) & Crosskey (M. E.). **The Horse-flies (Diptera: Tabanidae) of Nigeria and the British Cameroons.**—*Trans. R. ent. Soc. Lond.* **106** pt. 8 pp. 341–374, 60 maps, 43 refs. London, 1955.

A list, with locality records, is given of 91 species of Tabanids that have been reported to occur in Nigeria and the British Cameroons, and the distribution of the various species according to vegetation zones and seasonal distribution are shown in tables and discussed. Notes are given on breeding sites (about which little is known), and on the feeding habits of the adults and their attraction to light and to boats, trains and road vehicles. Finally, the importance of Tabanids as pests and vectors of disease is briefly discussed. The chief significance of members of the family lies in the intense annoyance they cause by their bites to man, cattle, horses and camels. It has not been established that they can transmit trypanosomiasis in Nigeria, but they probably act as mechanical vectors in Northern Nigeria, where occasional outbreaks occur among cattle many miles from territory infested by tsetse flies [*Glossina*] and camel trypanosomiasis, which is confined to the extreme north-east, is evidently not tsetse-borne. *Chrysops silacea* Aust. and *C. dimidiata* Wulp transmit *Loa loa* among the human population, and loiasis is not known to occur outside their range. The literature on the disease and its vectors published up to 1953 is briefly reviewed [*cf. R.A.E.*, B **44** 118–122, etc.].

Moore (B. P.). **Notes on the 2:4-Dinitrophenylhydrazine Method for Pyrethrum Assay.**—*J. Sci. Fd Agric.* **7** no. 12 pp. 740–744, 1 graph, 9 refs. London, 1956.

The following is virtually the author's summary. Experiments are described that have clarified the chemistry of the 2,4-dinitrophenylhydrazine method for pyrethrum and allethrin assay [*R.A.E.*, B **43** 36; **44** 168]. The fate during the course of analysis of a number of non-insecticidal contaminants has been determined, and the scope and limitations of the method are reviewed in the light of the new findings.

Papers noticed by Title only.

Oldroyd (H.). **The Horse-flies (Diptera: Tabanidae) of the Ethiopian Region. Volume III. Subfamilies Chrysopinae, Scepsidinae and Pangoniinae and a revised Classification.**—10 × 7½ ins., xii + 489 pp., 13 pls., 343 figs., 26 maps, 4½ pp. refs. London, Brit. Mus. (Nat. Hist.), 1957. Price £4 10*s*. [*Cf. R.A.E.*, B **40** 136; **42** 144.]

Rubtsov (I. A.). **Insects: Diptera. Vol. VI, pt. 6. Simuliidae** [of U.S.S.R.]. 2nd edn. [*In Russian.*]—*Fauna SSSR* N.S. no. 64, 10 × 6½ ins., 860 pp., 436 figs., 18 pp. refs. Moscow, Zool. Inst. Akad. Nauk SSSR, 1956. Price 51 *rub.* 20 *kop.* [*Cf. R.A.E.*, B **33** 204.]

Serdyukova (G. V.). **Ixodid Ticks of the Fauna of U.S.S.R.** [*In Russian.*] —*Opred. Faune SSSR* no. 64, 10 × 7 ins., 122 pp., 124 figs., 1 fldg. map, many refs. Moscow, Zool. Inst. Akad. Nauk SSSR, 1956. Price 7 *rub.* 90 *kop.*

Ross (H. H.). **A Textbook of Entomology.**—2nd edn., 9¼ × 6 ins., xi + 519 pp., 402 figs., many refs. New York, J. Wiley & Sons, Inc.; London, Chapman & Hall, Ltd., 1956. Price £3 2*s*. [*Cf. R.A.E.*, A **37** 261.]

Fluno (J. A.). **Insecticidal Phosphorus Compounds.**—*Soap & chem. Spec.* **31** no. 11 pp. 151–154, 203, 5 refs. New York, N. Y., 1955.

The results are given of tests, made against various insects at Orlando, Florida, in 1951–54, of Bayer L 13/59 (dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate), DDVP (dimethyl 2,2-dichlorovinyl phosphate), Shell OS 1836 (diethyl 2-chlorovinyl phosphate), several dialkyl homologues of each of these compounds, and the acetates of L 13/59 and its diethyl homologue. The most effective against fourth-instar larvae of *Anophcles quadrimaculatus* Say were the diethyl homologue of DDVP, which gave complete mortality in 48 hours at 0·025 parts per million, DDVP and its dipropyl homologue, which did so at 0·05 p.p.m., and L 13/59, its diethyl homologue and OS 1836, which gave about 95 per cent. mortality at 0·1 p.p.m. Saturated water solutions of L 13/59 and DDVP gave complete mortality in 24 hours at 1:100,000 and 96 and 86 per cent. mortality, respectively, at 1:250,000. Tested against adult body lice [*Pediculus humanus humanus* L.] of both sexes by exposing them for 24 hours on woollen patches impregnated with 1 per cent. solutions, the compounds that retained their effectiveness longest (for more than 31 days) were OS 1836 and its dimethyl, dipropyl and dibutyl homologues, L 13/59 and its acetate, and the dibutyl homologue of DDVP. In general, in each major chemical grouping, speed of knockdown of the lice decreased with increasing weight of the dialkyl radical.

DDVP, its diethyl homologue and OS 1836 gave 80, 100 and 100 per cent. knockdown in 30 minutes and mortality in 24 hours at 0·1 per cent. when tested as contact sprays in a wind tunnel with a draught of 3 miles per hour against female house-flies [*Musca domestica* L.]. They were considerably more effective than L 13/59, which gave 5 per cent. knockdown and 98 per cent. kill at 2 per cent. In laboratory tests of sugar baits, complete mortality of female house-flies in 24 hours was obtained with DDVP at 0·01 per cent., with its diethyl homologue and with L 13/59 at 0·1 per cent. and with OS 1836, the dipropyl homologue of DDVP and the diethyl homologue of L 13/59 at 1 per cent. In tests with 1 per cent. sugar baits sprinkled on the floors of heavily infested, unscreened dairy barns, DDVP and its diethyl and dipropyl homologues reduced fly populations more than L 13/59 in the first ten minutes, but all four compounds gave equal control (95 per cent. or more) after four hours. Deposits of DDVP at 25 mg. per sq. ft. on plywood were more effective than deposits of L 13/59 at 100 mg. against house-flies in the laboratory and gave complete mortality after 14 days with exposure for 60 minutes, but a deposit of 100 mg. DDVP per sq. ft. was effective for only 3–4 days in unscreened dairy barns. Deposits of L 13/59, the acetate of its diethyl homologue, DDVP and OS 1836 at 200 mg. per sq. ft. on plywood, all gave complete mortality in 24 hours of cat fleas [*Ctenocephalides felis* (Bch.)] and adult bed-bugs [*Cimex lectularius* L.] exposed for two hours on the day after they were applied. When the deposits were similarly tested a month later, the four insecticides gave 100, 90, 90 and 0 per cent. kill, respectively, of the bugs, and the first three gave 100, 80 and 70 per cent. kill of the fleas.

Neeman (M.) & Modiano (A.). **Studies in selective Toxicity. I. Syntheses of *N*-Alkylbenzenesulfonanilides.**—*J. org. Chem.* **21** no. 6 pp. 667–670, 4 graphs, 10 refs. Easton, Pa., 1956.

The 24 compounds discussed in this paper comprise the homologous series of N-n-alkyl-4-bromo- and -4-chloro-benzenesulphon-4′-chloroanilides with n-alkyl radicals up to dodecyl (except undecyl), and two modifications of the bromobenzene compound in which the N-radical was isoamyl or

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β-chloroethyl. The methods of preparing them are outlined and their properties are described, including a brief note on their biological activity. The N-methyl and N-ethyl chlorobenzene compounds had already been shown [*R.A.E.*, B **43** 28] to act as synergists for DDT against DDT-resistant house-flies [*Musca domestica* L.] but are not considered of practical value, because of their negligible solubility in kerosene, which is the solvent commonly used for DDT solutions, and their low solubility in the aromatic hydrocarbons used in DDT emulsion concentrates. The solubility in kerosene of the compounds of both series increased with alkyl length up to a maximum for n-hexyl in the bromo series and n-heptyl in the chloro series. In both series, oscillation of the solubility in kerosene was observed between homologues with an even and an odd number of carbon atoms in the N-alkyl radical, up to n-amyl. The solubility of the compounds in benzene and xylene increased very rapidly on increase of the N-n-alkyl radical. Their solubility was very high in ketones (acetone, butanone) and extremely low in water.

The compounds showed little or no toxicity to rats or insects when tested by themselves, but some of them were highly active as synergists for DDT against DDT-resistant house-flies [*M. d. vicina* Macq.]. Those that showed synergistic action comprised all the N-n-alkyl compounds up to and including n-octyl and the β-chloroethyl derivative. The curves relating synergistic activity of the N-n-alkyl compounds to the number of carbon atoms in the n-alkyl radical differed greatly with the method of test. When the flies were treated by topical application of dilute benzene solutions, the N-methyl compound was the most active in each series, but when the flies were subjected to short contact with a deposit [**40** 181], the N-n-hexyl compound was the most active of the 4-bromobenzene series and the N-n-heptyl and N-methyl compounds were classed as showing maximum activity in the 4-chlorobenzene series. The effects of such factors as intrinsic synergistic activity and availability by pick-up from deposits and cuticular penetration in relation to chemical structure and physical properties of the compounds are to be the subject of another paper.

Neeman (M.), Modiano (A.) & Shor (Y.). **Studies in selective Toxicity. II. Substituted Phenyl Benzoates and Benzenesulfonates.**—*J. org. Chem.* **21** no. 6 pp. 671–672, 5 refs. Easton, Pa., 1956.

The following is virtually the authors' summary. Twenty-six phenyl benzoates and benzenesulphonates, mono-, di-, or tri-substituted by methyl, chlorine and/or bromine, have been synthesised and tested for toxicity against larvae of *Ornithodoros tholozani* (Lab. & Mégn.) and both eggs and larvae of *Musca domestica vicina* Macq. No significant toxicity has been observed.

Thomson (R. C. Muirhead-). **Communal Oviposition in** *Simulium damnosum* **Theobald (Diptera, Simuliidae).**—*Nature* **178** no. 4545 pp. 1297–1299, 6 refs. London, 1956.

The only published information on the oviposition habits of *Simulium damnosum* Theo. is that provided by the findings of Wanson & Henrard [*R.A.E.*, B **36** 147]. Repeated observations over several months in a comparatively small stream in Liberia, in which *S. damnosum* was breeding regularly, failed to reveal any sign of ovipositing females or egg batches until March 1956, when Simuliid eggs were found on broad leaves of bushes that had recently been cut down along the stream edge. The eggs were laid

in large irregular masses, often, it was estimated, at a rate of 2,000–3,000 eggs per sq. cm. on leaves that were dipping into the stream. One particular mass measuring 30 sq. cm. was believed to comprise at least 50,000 eggs. As the larvae that hatched could not be kept alive for more than a few days, and other species of *Simulium* were present in the stream and on the leaves it was not certain that the eggs were those of *S. damnosum*. During examination of many similar sites in the following weeks, further batches of eggs were seen twice on trailing leaves and twice on rattan strands dipping into the water.

In August, when fresh batches of eggs had been recorded on several consecutive days at a series of artificial sites formed by leafy twigs trailing in a stream, a careful watch was kept from one hour before dusk. No activity was evident until sunset, when a dense swarm of adults of *S. damnosum* was seen just above the surface, where the tips of the leaves touched the water. They quickly settled on the leaves, and mass oviposition immediately began. Those that settled at the tip of one leaf moved together from apex to base, forming a continuous line from one side to the other, and leaving a solid mass of eggs behind them. Eggs were also being laid on two or three leaves on the same twig but not on any of the eight similar twigs nearby. By the time maximum activity was reached, it was almost dark. Tubes slipped over two of the leaf tips when the peak of activity was passed secured 48 and 50 females of *S. damnosum*, respectively. Many escaped and many others had already left. Observations made by Dalmat to the effect that a given species of *Simulium* may vary its ovipositing habits according to site and conditions, combined with the rather different behaviour of *S. damnosum* originally recorded [*loc. cit.*], indicate that this communal oviposition may not always occur. As the type of site on which mass oviposition was observed is rather unusual, others must be used as well to account for the almost continuous production of larvae in the stream over long periods.

Barlow (F.) & Hadaway (A. B.). **Effect of Changes in Humidity on the Toxicity and Distribution of Insecticides sorbed by some dried Soils.** —*Nature* **178** no. 4545 pp. 1299–1300, 4 refs. London, 1956.

An apparent correlation has recently been noticed between relative humidity and the effectiveness against mosquitos of insecticide deposits in houses with mud walls. Laboratory experiments showed that kills of mosquitos that had been treated topically with DDT, γ BHC, dieldrin or Diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] or exposed to deposits of wettable powders of DDT, γ BHC or dieldrin were not affected by the relative humidities at which the mosquitos were subsequently kept. These ranged from 20 to 95 per cent. It therefore seemed that relative humidity must modify the availability of the insecticide to the insect. It has been shown that blocks of the air-dried soils that are often used for building houses in the tropics can rapidly adsorb insecticides applied as surface deposits of wettable powders [*cf. R.A.E.*, B **44** 3–4, etc.], thereby decreasing contact action, and it was noticed that increased relative humidity reduced the rate at which DDT and γ BHC disappeared from the surface. Further investigation confirmed that the rate of sorption of deposits of DDT, γ BHC and dieldrin on blocks of Uganda soil decreases as humidity increases, and showed the same to be true with nine other soils. They also showed, however, the importance of ascertaining what happens after sorption is completed, since dieldrin, even at 100 mg. per sq. ft. and 90 per cent. relative humidity, disappeared from the surface of Uganda mud blocks in about five days.

Mud blocks sprayed 21 days earlier with a suspension of dieldrin crystals in the size range 0–10μ at 100 mg. per sq. ft. and kept for 24 hours at 90 and 40 per cent. relative humidity gave 100 and 0 per cent. kill of females of *Aëdes aegypti* (L.) in 8 minutes and 100 and 30 per cent. in 30 minutes, respectively. When the humidities at which the blocks were kept were reversed for a further 24 hours, they gave 5 and 100 per cent. kill, respectively, in 16 minutes. Similar results were obtained for contact action of DDT and both contact and fumigant action of γ BHC. Chemical determination of the distribution of the insecticides in the blocks kept at different humidities showed that the rate of diffusion into the blocks after complete sorption increased with humidity, and the concentration near the surface of the blocks on which the insects rested accordingly decreased.

In the field, therefore, long periods of high humidity would be expected to give a progressive decrease in the concentration of insecticides near the surface of the walls, whereas lower humidities would tend to keep it static. However, at any given time and concentration, an increase in humidity would increase kills. The enhanced kill at high humidities can more than compensate for decreases in concentration so that kills would remain high even during long periods of high humidity.

The results are explained on the basis of competition between the water and the insecticide. Water appears to be adsorbed preferentially to the insecticide and the increased amounts present in soils at high humidities have two effects. The initial disappearance of the insecticide from solid particles lying on the surface is retarded, because water molecules already occupy a large part of the "active" surface and cannot be displaced. Once the insecticide is adsorbed, however, the same preferential adsorption of water results in an increased mobility of the insecticide molecules and therefore an enhanced rate of diffusion into the soil or on to and into an insect resting on the surface.

Crosskey (R. W.). **The Simuliidae (Diptera) of Northern Nigeria.**—*Bull. ent. Res.* **48** pt. 1 pp. 59–74, 1 fig., 7 maps, 8 refs. London, 1957.

The following is the author's summary. Fourteen species of Simuliidae (of which one occurs in two forms) are recorded from Northern Nigeria. Localities for each species are given on distribution maps. Most of the species are of fairly general occurrence in the Ethiopian Region, although *Simulium kenyae* De Meillon is recorded for the first time from West Africa. No new species was found in an extensive survey of about 200,000 square miles.

Some notes are included on the breeding habits of the species, particularly the type of breeding site preferred, the altitudes at which breeding occurs, and the months in which immature stages have been found.

Some discussion is given of the distribution of Simuliidae in Northern Nigeria and the factors which appear to influence it, partly illustrated by maps. The most important factor is thought to be the geology of the country, which determines the areas of rivers suitable for breeding. Other factors such as climate, altitude, or vegetation zones, seem to play little part, except in the far north.

Lewis (D. J.). **Observations on Chironomidae at Khartoum.**—*Bull. ent. Res.* **48** pt. 1 pp. 155–184, 1 pl., 9 figs., 67 refs. London, 1957.

The following is taken from the author's summary. This paper deals mainly with species of *Tanytarsus* at Khartoum, particularly the very

common *T. lewisi* Freeman [*cf. R.A.E.*, B **44** 66, 123]. These midges are a serious pest there, usually between November and April, causing great annoyance by swarming in vast numbers around lights during the first few hours after sunset and thus interfering with work and pleasure in the riverain area. They are probably responsible for a considerable amount of asthma and other reactions due to allergy. The conditions under which they occur at Khartoum and the methods of study are described.

At least 26 species of Chironomids, including four of *Tanytarsus*, occur at Khartoum. The respiratory organs of some pupae are figured, and a key, based on the characters of these organs, is given for some of the species. Observations on the biology of all stages are recorded, particularly on the vertical movements and drifting of larvae and pupae and the time of emergence. Many larvae and pupae drift downstream at night, and *T. lewisi* emerges mainly in the early morning. Some exploratory field trials of larvicides were carried out [*cf.* **44** 67]. The results were inconclusive, and the difficulty of assessing them is pointed out. Thorough control by anti-larval measures would be extremely difficult owing to the large size of the river and the drift of pupae from upstream. It is believed that it might be possible but prohibitively expensive, and would have to be repeated annually, perhaps throughout the midge season. Various protective measures are discussed. It is considered that riverside dwellers who can do so should move inland, and that a barrier of trees parallel to the river would protect houses away from the river front. People who must be near the river in the evening can achieve considerable protection by clearing some vegetation, fogging with insecticide, or using air-cleaning or air-conditioning equipment.

CAMERON (E.). **On the Parasites and Predators of the Cockroach. II.** *Evania appendigaster* (**L.**).—*Bull. ent. Res.* **48** pt. 1 pp. 199–209, 7 figs., 16 refs. London, 1957.

In the first paper of this series, a general account was given of the natural enemies of cockroaches, and *Tetrastichus hagenowii* (Ratz.), one of the most important, was dealt with in some detail [*R.A.E.*, B **43** 91]. Investigations on the bionomics of *Evania appendigaster* (L.), which appeared to be the next most important subject for further research and may be regarded as typical of a group of some ten Evaniids that parasitise cockroach oothecae, are described in the present paper. The species was studied in oothecae of *Periplaneta americana* (L.) from Saudi Arabia, 25–29 per cent. of which were parasitised by it. The following is based on the author's summary of the findings. There are at least three or four generations a year. Adult parasites emerged from the Arabian material in or about February, May and October. Only one egg is laid in each ootheca, and the solitary larva devours all the host eggs. There are five larval instars. The mature larva is described in detail, and recognition characters are given for egg, larval instars and adults.

The value of *E. appendigaster* and *T. hagenowii* in the control of cockroaches is discussed. It is pointed out that *T. hagenowii* in certain areas destroys 15–57 per cent. of the eggs of its host, and both this species, with up to six generations a year, and *E. appendigaster*, with three or more, multiply much more rapidly than the host, which has less than one. It appears that where they occur together, they could destroy up to half the cockroach population. The host records and general distribution of *E. appendigaster* and nine other Evaniids, all of which parasitise the oothecae of cockroaches, are given, with references to the literature. *E. appendigaster* has been recorded from *Blatta orientalis* L. in Hungary and Egypt, *Periplaneta* sp.

in Fiji, *P. americana* in Jamaica and Palestine, and *P. americana*, *P. australasiae* (F.), *Cutilia soror* (Brunner) and *Neostylopyga rhombifolia* (Stoll) in Hawaii, and it is stated to be common in Arizona and in the cities of the Gulf and Atlantic States as far north as New York.

Shewell (G. E.). **Identity of the Black Fly that attacks Ducklings and Goslings in Canada (Diptera: Simuliidae).**—*Canad. Ent.* **87** no. 8 pp. 345–349, 14 refs. Ottawa, 1955.

For many years, *Simulium venustum* Say has been regarded as the chief vector of *Leucocytozoon simondi*, which causes a disease of ducks and geese, usually fatal to immature birds, in Canada and the United States [*cf. R.A.E.*, B **40** 73, etc.]. However, recent studies in eastern Canada have led the author to doubt that *S. venustum* is the species concerned. In 1953, he found that ten female Simuliids in the Canadian National Collection that had been part of an infestation found by Walker to be causing the death of goslings at Fredericton, New Brunswick, were not *S. bracteatum* Coq. (a synonym of *S. aureum* Fries) as reported by Walker [**15** 192] or *S. venustum* as suggested by Twinn [**21** 92], but *S. rugglesi* Nicholson & Mickel, which was described in 1950 [**40** 73] from geese in Minnesota. Adults of *S. rugglesi* were taken swarming around ducklings at Fredericton in the summer of 1954. Catches made during a survey of the Simuliids of this area in the same year included 162 individuals of *S. rugglesi* taken on 29th and 30th June at Oromocto, of which 52 were engorged females taken from the bodies of ducklings and the rest were netted while hovering over the birds, whereas four collections made between 17th June and 9th July of Simuliids biting or hovering around man consisted of 316 adults of *S. venustum* and 49 of *Prosimulium hirtipes* (Fries). An engorged female of *S. rugglesi* taken on the 9th July on the window of a poultry shed was the only Simuliid found on a property near Ottawa on which 20 ducklings out of 45 had just died and *Leucocytozoon* was suspected. Of several hundred specimens of *S. venustum* in the Canadian National Collection, none bears a label indicating a connection with any kind of bird. In view of these findings, it is felt that O'Roke's work [**21** 92; **22** 108], on which the acceptance of *S. venustum* as a vector of *L. simondi* almost entirely rests, is in need of confirmation.

Available evidence suggests that the main vector of *L. simondi* appears in June and reaches a peak of abundance in the first or second week of July [**22** 108]. The seasonal prevalence of *S. venustum* at latitudes approximating that of northern Michigan where O'Roke worked does not conform to this pattern. In the Ottawa district, *S. venustum* begins to emerge in the middle of May, and its populations reach a peak in the middle of June and fall off considerably by the end of the first week of July. Data from casual collections in northern Minnesota, Ontario and Quebec are consistent with this seasonal incidence, whereas all data on the occurrence of *S. rugglesi* suggest that it does not emerge until the third or fourth week of June. It has been observed that *S. rugglesi* feeds beneath the feathers of the breast and abdomen of the host and tends to remain hidden at the bases of the feathers after feeding. Its strongly toothed tarsal claws, which resemble those found in typical species of *Eusimulium* (*S. aureum*, etc.) and in Hippoboscids may be an adaptation concerned with ease of movement beneath feathers. Most of the American Simuliids with simple or minutely toothed claws feed on mammals, whereas of the ten species with Hippoboscid-like claws for which biting records are available, seven attack birds. The type of stream in which *S. rugglesi* breeds is not known. A preference for sluggish water might account for the comparatively late appearance of

the adults and also impose on the species an uneven population density throughout its range that would account for the apparently sporadic and unpredictable nature of epizootics caused by *L. simondi*.

BALDWIN (W. F.), JAMES (H. G.) & WELCH (H. E.). **A Study of Predators of Mosquito Larvae and Pupae with a Radio-active Tracer.**—*Canad. Ent.* **87** no. 8 pp. 350–356, 2 graphs, 10 refs. Ottawa, 1955.

Assessment of the effectiveness of predators in the control of mosquito larvae requires a technique to identify individuals that have consumed prey. To determine whether a radioactive tracer could be used, insects of several species were fed on mosquito larvae that had been kept for 24 hours in distilled water containing 0·05 μc. (microcurie) ^{32}P per ml. and had an average radioactivity of 480 counts per minute. The radioactivity counts of individual predators 24 hours after they had fed ranged from 75–120 in those that had consumed one larva to 1,300 in one that had consumed ten. For field experiments, four ponds were walled off in a large permanent pool in a swamp in Ontario in 1953, and larvae of *Aëdes stimulans* (Wlk.) and *A. trichurus* (Dyar) from them were tagged by keeping them for 24 hours in trays of pond water containing ^{32}P as phosphoric acid at 0·05 μc. per ml. They were then washed twice in fresh pond water and kept in pond water for two days to rid themselves of radioactive excreta. Where this step was omitted in preliminary experiments, the ponds were contaminated and all the fauna in them became radioactive. Treated larvae were returned to ponds I, II and III on 14th April, 22nd April and 5th May, respectively, or kept and returned as pupae to pond IV on 11th May. As many examples as possible of the macroscopic pond fauna were collected on the following day and tested for radioactivity.

The results, which are given in tables and discussed, showed that pond-snails and several species of insects preyed on the mosquito larvae and pupae. The importance of the predators as control agents was evident from the numbers that became radioactive and also from the high radioactivity of certain kinds, particularly Dytiscids and larvae of *Limnephilus indivisus* Wlk. *L. indivisus* and two other insects are recorded as mosquito predators for the first time. The increase in the density of predators as the season advanced was accompanied by a decrease in the density of the mosquitos; the estimated numbers of mosquito larvae or pupae and of other animals per sq. metre and (in brackets) the percentages radioactive were 1,414 (24·7) and 2·6 (18·8) in pond I, 1,727 (68·4) and 9·5 (19·2) in pond II, 1,097 (56) and 39 (30) in pond III, and 930 (66) and 79 (86·9) in pond IV. The numbers of species shown to be predacious in the successive ponds were 2, 6, 6 and 9. The actual numbers of larvae of *L. indivisus* and larvae and adults of Dytiscids taken in May (with the numbers radioactive in brackets) were 125 (40), 5 (5) and 16 (12) in pond III (6·2 sq. metres), and 371 (369), 11 (10) and 12 (10) in pond IV (5·7 sq. m.), and the high radioactive counts of the Dytiscids suggested that they consumed many larvae and pupae.

SHEMANCHUK (J. A.), FREDEEN (F. J. H.) & KRISTJANSON (A. M.). **Studies on Flight Range and Dispersal Habits of *Aedes flavescens* (Müller) (Diptera: Culicidae) tagged with Radio-phosphorus.**—*Canad. Ent.* **87** no. 9 pp. 376–379, 3 refs. Ottawa, 1955.

About 415,000 larvae of *Aëdes flavescens* (Müll.) were collected from sloughs at Indi (Saskatchewan) in May 1952, kept in tubs in water containing 0·1μc. ^{32}P per ml. [*cf. R.A.E.*, B **42** 198] for periods (19–45 hours) long enough for the average radioactivity of sample larvae to exceed 3,000

disintegrations per minute, and then returned to one of their natural habitats. The batches of tagged larvae were released daily from 10th to 15th May, and about 1,500,000 adults were collected with hand nets between 17th May and 20th June at various distances (up to 14 miles) from the release site. These included 82 tagged mosquitos (0·02 per cent. of the tagged larvae), all of which were obtained between 21st May and 6th June and at distances from the release site ranging up to 6·6 miles for females and 1,400 yards for males. The average radioactivities of the tagged larvae and adults were 8,130 and 560 disintegrations per minute, respectively, indicating a loss of 93 per cent. of the original radioactivity, of which about 56 per cent. could be accounted for by decay of the ^{32}P.

It was observed in this experiment that the larvae needed the longer periods of treatment to acquire adequate radioactivity when the weather was cool, and the effect of temperature was confirmed by a laboratory test in which disintegration per minute for larvae kept for 15, 40 and 60 hours in pond water containing 0·1μc. ^{32}P per ml. at 34 and (in brackets) 76°F. were 1,250 (33,000), 2,860 (82,200) and 3,320 (121,000).

Of larvae kept for 24 hours in water containing 1 and 0·1μc. ^{32}P per ml., 100 and 41 per cent. died in four days, while control mortality was 36·5 per cent. Treatment at 0·1μc. retarded the emergence of adults by about three days, but did not appreciably affect their life-span.

Salt (R. W.). **The Concept of Survival in Preference to that of Mortality.** —*Canad. Ent.* **87** no. 9 pp. 380–382, 1 ref. Ottawa, 1955.

The effect of exposing insects to an insecticide or any other adverse agent is usually assessed as the observed mortality after an arbitrarily selected interval, but this disregards the subsequent fate of the survivors. Sublethal treatment causes effects that vary in permanence and severity, but may be sufficient to inhibit the major developmental changes. Arbitrary mortality counts may be adequate for some comparative purposes, but survivors should be considered for determination of the relative effectiveness of different dosages, since the potentialities for effective reproduction of insects that survive high and low dosages will be different.

Wolcott (G. N.). **Entomología económica puertorriqueña.** [The economic Entomology of Porto Rico.]—*Bol. Estac. exp. agric. P. R.* no. 125 (1955), 208 pp., 1 pl., 133 figs. Río Piedras, P. R. [1956.] (With a Summary in English.)

This bulletin is devoted mainly to agricultural pests [*cf. R.A.E.*, A **45** 229], but includes brief sections on arthropods of medical or veterinary importance in Porto Rico and their control.

Rajagopalan (N.), Vedamanikkam (J. C.) & Raghupathi Ramani (S.). **Tolerance of Larvae of *Culex fatigans* Wiedemann to Gammexane applied as a Larvicide at Kumbakonam, South India.**—*Indian J. Ent.* **17** pt. 2 pp. 159–164, 1 ref. New Delhi, 1955.

The town of Kumbakonam lies in the Cauvery delta, and as it is largely below river level, drainage is inadequate and mosquitos that breed in stagnant and polluted water are prevalent. Larvicides have been used for their control since 1935, and BHC, which was first used in April 1952, gave good results until the end of 1953, when it appeared to be losing its effectiveness. When larvae of *Culex pipiens fatigans* Wied. from the town were investigated in the laboratory in comparison with larvae from Madras

City, they were found to possess a high degree of resistance to BHC. Field tests were carried out at Kumbakonam and Rajagiri (about ten miles away) with BHC, DDT and dieldrin applied at rates of 3·75, 3·5 and 0·5 lb. per acre in wettable-powder suspensions. Larval and pupal populations of *C. p. fatigans* were assessed before and 24 hours after treatment, and mortality was satisfactory at Rajagiri but very poor at Kumbakonam, even dieldrin, which had not previously been used there, failing to give much control. When the same insecticides were tested in the laboratory, the mortality percentages in three and (in brackets) 24 hours were 0 (14) for BHC, 44 (81) for DDT and 0 (72) for dieldrin against larvae from Kumbakonam and 100, 74 (100) and 48 (92), respectively, against those from Rajagiri. In further tests, adults of *C. p. fatigans* from the two places were confined for 30 minutes on plywood bearing deposits of BHC at 10 mg., DDT at 50 mg., and dieldrin at 20 mg. per sq. ft. The mortality percentages were 1·5, 4·3 and 2·2, respectively, for the mosquitos from Kumbakonam and 100, 26·3 and 10 for those from Rajagiri. Resistance to BHC was, however, completely lost in laboratory colonies of *C. p. fatigans* from Kumbakonam after they had been reared for two generations without exposure to it.

Chamberlain (R. W.), Sudia (W. D.) & Nelson (D. B.). **Laboratory Observations on a Mosquito, *Culiseta melanura* (Coquillett).**—*Mosq. News* **15** no. 1 pp. 18–21, 1 fig., 4 refs. Albany, N. Y., 1955.

Culiseta melanura (Coq.), which is seldom met with but widely distributed in swampy areas of the southern and eastern United States, has acquired interest as a possible vector of western and eastern equine encephalitis, as the viruses of both have recently been isolated from it. Little is known about its bionomics, and an attempt was therefore made to establish a colony in the laboratory. Larvae in the second, third and fourth instars were collected from seepage holes in a swamp in Georgia in November 1951 when temperatures were near freezing at night and transported in water from the breeding place to a laboratory in Alabama. Some were immediately kept at 80°F., and nearly all these died within 18 hours. The others were kept in an unheated room for about a week, at the end of which the midday temperature was about 80°F., and were then transferred to the insectary with no apparent ill effects. They were reared in water from the breeding place, to which small pieces of compressed lucerne rabbit pellets were added as food, and required 2–5 weeks to complete their development, which was probably retarded owing to the prior conditioning to cold. The pupal stage lasted 2–3 days. The adults were kept in small cages and were not observed to pair. They fed readily on soaked raisins, but only 10 per cent. of the females fed on a chick and 30 per cent. on a rabbit after being deprived of raisins for 36–48 hours. A single engorged female taken in Louisiana in 1953 was shown by the precipitin test to have ingested avian blood. Egg rafts were deposited by 11 out of 17 females 4–6 days after they had fed on rabbit and by some females that had fed on a chick, but none of the eggs hatched.

Nelson (D. B.) & Chamberlain (R. W.). **A Light Trap and mechanical Aspirator operating on Dry Cell Batteries.**—*Mosq. News* **15** no. 1 pp. 28–32, 2 figs. Albany, N. Y., 1955.

Operation of the New Jersey suction light-trap [*cf. R.A.E.*, B **23** 151] is limited in areas in which batteries have to be used to supply the electricity for it, because they are heavy to transport and costly to use; even in a modified trap operated from 6-volt car batteries, the weights of trap and

batteries are about 15 and 60 lb., the batteries are expensive, and daily recharging is necessary. Details are given of the construction of a miniature trap of the same type that weighs only 1½ lb. and needs dry batteries weighing only 4 lb. to supply current for the light and the motor of the suction fan. The main disadvantage of the trap is its limited range of attraction because of the weakness of the light. It can be used most effectively in wooded areas where lights cannot carry far regardless of intensity and the mosquito population is generally high. The composition and density of the collections made appeared to be fairly consistent for a particular area. This indicates that the samples obtained may give a reliable index of the light-attracted mosquito population.

Details are also given of the construction of an aspirator, in which the same type of motor was incorporated, and with which up to 100 resting and feeding mosquitos could be caught before the catch had to be discharged into a separate container.

Baker (W. C.) & Schoof (H. F.). **Temporary Control of Adult Mosquitoes at Outdoor Places of public Assembly.**—*Mosq. News* **15** no. 1 pp. 32–34. Albany, N. Y., 1955.

Single fog applications of solutions (in equal parts of fuel oil and kerosene) of 2·5 or 5 per cent. DDT, 1 or 2 per cent. chlordane or 0·25 per cent. pyrethrins with 2 per cent. piperonyl butoxide gave effective protection from annoyance by *Aëdes sollicitans* (Wlk.) and *A. taeniorhynchus* (Wied.) for a whole evening over an area of six acres in a lowland surrounded by woods near Savannah, Georgia. The mosquitos entered the area at dusk in summer and were most active in the next 20–30 minutes. The insecticide was dispersed from a portable jet propulsion fogging unit fitted with a small-aperture nozzle. The fog was first applied in a barrier strip round the perimeter of the area and then in the interior of it. The operation began 15 minutes after infiltration started, took 10–15 minutes to complete, and required about 1·1 U.S. gal. insecticide solution. Treatment 20 minutes before infiltration did not give effective protection.

Cook (D. R.) & Foote (R. H.). **Pictorial Keys to the Mosquitoes of medical Importance. IX. Australian Region.**—*Mosq. News* **15** no. 1 pp. 35–38, illus., 6 refs. Albany, N. Y., 1955.

These keys are similar in design to the others of the series [*R.A.E.*, B **43** 197: *cf.* also **44** 144]. The area covered by them comprises Timor, the Moluccas, New Guinea, Micronesia, Melanesia, Polynesia, Australia and New Zealand, and the mosquitos that they are intended to differentiate are species of *Anopheles* and *Aëdes* that are of actual or potential importance as vectors of malaria and dengue; vectors of *Wuchereria bancrofti* are not considered as such.

Blanton (F. S.), Keenan (C. M.) & Peyton (E. L.). **Mosquitoes collected in Horse-baited Traps in Panama during 1951 to 1953 inclusive as an Index to Malaria Control.**—*Mosq. News* **15** no. 1 pp. 39–42, 9 refs. Albany, N. Y., 1955.

Between January 1951 and October 1953, 161,284 mosquitos were caught in 4,478 trap-nights in horse-baited traps [*R.A.E.*, B **33** 96] installed at Army posts in Panama to provide data on mosquito populations and indications of the effectiveness of anti-Anopheline measures. A list shows the numbers of each species taken; they belonged to 14 genera. Those of

the genus *Anopheles* included 17,960 examples of *A. punctimacula* D. & K., 6,602 of *A. albimanus* Wied., 6,413 of *A. aquasalis* Curry and some 7,000 of 11 other species. The numbers of *A. albimanus* taken per trap-night varied from 0·02 at one of the posts at which control measures were in operation to 54·3 in an area in which no control was attempted.

Barnett (H. C.). **Cage Equipment for the Study of Mosquitoes infected with pathogenic Agents.**—*Mosq. News* **15** no. 1 pp. 43–44, 2 figs., 1 ref. Albany, N. Y., 1955.

Descriptions are given of two cages, one for batches of 25–250 mosquitos and one for individual females. They were designed to be simple to make and use, to be transparent enough to allow slight blood-meals in the mosquitos to be seen, and to minimise the risk of escape of mosquitos infected with disease agents. The large cage was a cylinder (20 inches high and 7–12 inches in diameter) of 0·02-inch cellulose-acetate sheeting with a wooden disk bottom and a cover of cloth or plastic netting on a ¾-inch wooden rim at the top. The seam of the cylinder was sealed by treatment with acetone and pressure, and the same method was used to attach a piece of cotton stocking to the edges of a 4-inch circular hole as a sleeve. The top and bottom were secured by tacks and sometimes adhesive tape. Mosquitos were allowed to emerge from pupae in small beakers in the cage. Birds with clipped breast feathers and legs taped together were exposed in cylindrical holders of wide-mesh wire cloth suspended in the cage.

The small cage was made of a rectangle of the cellulose acetate (in which a ¾-inch hole had been made) fitted tightly and sealed with acetone over a cylindrical ice-cream carton to form a cylinder four inches high. The cylinder was reinforced internally at the top with a cardboard ring cut from another carton. A small paper cup was put in the carton to hold water. The top was then covered with netting fixed to the cylinder with acetone, and the hole was covered with adhesive tape. Mosquitos were introduced or removed through the hole with an aspirator. Birds to be exposed to mosquitos were tied down with a clipped area against the netting. When cotton soaked with sugar-water was to be put on top of either cage to provide food, a cover of plastic netting was preferable to one of cotton netting. Some lots of thicker cellulose-acetate sheeting were found to be toxic to mosquitos, presumably because a phthalate had been used in their manufacture [*cf. R.A.E.*, A **42** 100–101], but this did not occur with sheeting 0·02 inch thick or less.

Notananda (V.). **A simple Mounting Medium for Mosquito Larvae.**—*Mosq. News* **15** no. 1 p. 45. Albany, N. Y., 1955.

Trees of the genus *Dipterocarpus* are common in Siam and exude resin when the bark is broken. It was found that a simple mounting medium for mosquito larvae could be prepared in the field by dissolving the resin in a suitable solvent (10 gm. resin in 5 cc. xylene or 10 cc. eucalyptus oil). Newly exuded lumps of resin, which are clear and colourless, must be used.

Jeffery (G. M.) & Eyles (D. E.). **Infectivity to Mosquitoes of *Plasmodium falciparum* as related to Gametocyte Density and Duration of Infection.**—*Amer. J. trop. Med. Hyg.* **4** no. 5 pp. 781–789, 3 graphs, 9 refs. Baltimore, Md., 1955.

The following is largely based on the authors' summary. Females of *Anopheles quadrimaculatus* Say were fed on 29 people infected with a strain

of *Plasmodium falciparum* from South Carolina and females of *A. albimanus* Wied. on 59 infected with a Panama strain. Feeding was carried out at all stages of infection. Observations were made on the relations of gametocyte density and length of patency to infectivity. Mosquitos often became infected when fed on blood containing less than 10 gametocytes per cu. mm., and were infected as late as day 321 of parasite patency in the Carolina strain and 410 in the Panama strain. It is concluded that the long-enduring parasitaemias of these strains are of considerable epidemiological importance and may be responsible for much of the transmission of *P. falciparum* in certain endemic areas.

Dehné (E. J.). **Fifty Years of Malaria Control in the Panama Area.**—*Amer. J. trop. Med. Hyg.* **4** no. 5 pp. 800–811, 4 figs., 22 refs. Baltimore, Md., 1955.

The efforts to control malaria in the neighbourhood of the Panama Canal during the fifty years from 1904 to 1953 became progressively more successful as new methods developed. The work is reviewed by decades. The measures taken in the early years were similar in outline to those still in use, namely therapeutic and prophylactic treatment with drugs, screening of houses, killing of adult Anophelines in dwellings and removal of resting places, use of larvicides and elimination and modification of breeding places. The situation in the terminal cities improved rapidly as a result of permanent engineering measures, and malaria became largely a rural disease. It persists in all provinces of the Republic of Panama. Blood and mosquito surveys in areas that border the Canal Zone show a recurring high prevalence of malaria that serves as a reservoir of infection from which an abundant Anopheline population can transmit the disease. Intensified mosquito control in 1949, aimed principally at the vectors of yellow fever, also resulted in a fall in malaria rates in 1950 to the lowest level ever recorded. The rates in troops and Canal-Zone civilians increased again in 1951. The endemic malaria responds well to drugs and anti-Anopheline measures but returns to its previous level when control efforts are interrupted. Continuing and unremitting application of control measures should become a permanent part of community routine. Anopheline control by insecticides has culminated in the use of DDT [*R.A.E.*, B **37** 213]. Indications of a modified response of *Anopheles albimanus* Wied. to DDT have been recorded in Panama, but resistance has not become a practical problem where house spraying is done at intervals not exceeding four months [**42** 105]. Mounted mist blowers and hand sprays are used for the control of larvae and have been shown to be more effective than fogging. Spraying with DDT from aircraft is occasionally used as an adjunct in the treatment of inaccessible breeding places. The maintenance of drainage ditches is being improved by the use of new weed killers.

Downs (W. G.), Aitken (T. H. G.) & Anderson (C. R.). **Activities of the Trinidad Regional Virus Laboratory in 1953 and 1954 with special Reference to the Yellow Fever Outbreak in Trinidad, B.W.I.**—*Amer. J. trop. Med. Hyg.* **4** no. 5 pp. 837–843, 2 maps, 5 refs. Baltimore, Md., 1955.

When a laboratory for the investigation of virus diseases was established in Trinidad early in 1953, no case of yellow fever had been recorded on the island since 1914. However, neutralisation tests on the sera of residents in

July–August 1953 revealed immunity in 0, 8 and 4·2 per cent. of those 1–14, 15–19 and 20–29 years of age. Yellow-fever virus was isolated from 14 of 15 human cases that occurred during April–October 1954, and isolations were also made from seven red howler monkeys (*Alouatta*) brought in dead, 21 pools of *Haemagogus spegazzinii spegazzinii* Brèthes and one mixed pool of 17 species of mosquitos. Many of the adults of *Haemagogus*, including all those in some of the positive pools, were caught at ground level. Attempts to isolate virus from females of *Aëdes aegypti* (L.) found during a search in houses with confirmed cases of yellow fever and in others with undiagnosed fevers were unsuccessful. At least three of the human cases appeared on epidemiological grounds to be due to transmission by *A. aegypti*, including one from urban Port-of-Spain. The remaining cases were probably all infected in the forest, but the occurrence of *A. aegypti* in suitable breeding containers throughout the island and *aegypti* indices of 20 per cent. or more in rural houses makes it seem possible that some rural cases are transmitted by *A. aegypti*. Available evidence suggested that there had been an extensive epizootic among the howler monkeys with high mortality. Neutralisation tests on the sera of monkeys shot for the purpose showed evidence of immunity in 19 of 61 howler monkeys and 7 of 12 capuchin monkeys (*Cebus*).

Taylor (R. M.), Hurlbut (H. S.), Work (T. H.), Kingston (J. R.) & Frothingham (T. E.). **Sindbis Virus: a newly recognized Arthropod-transmitted Virus.**—*Amer. J. trop. Med. Hyg.* **4** no. 5 pp. 844–862, 2 maps, 8 refs. Baltimore, Md., 1955.

Data are given on the characteristics of the virus that was first isolated in northern Egypt from a pool of *Culex* mosquitos, almost certainly including *C. univittatus* Theo. and possibly *C. pipiens* L. also, and was readily transmitted by both these mosquitos [*R.A.E.*, B **43** 129–130]. It is fatal to embryonated hens' eggs and is markedly cytopathogenic to outgrowths of fibroblastic cells in chick embryo tissue cultures. It causes paralysis and death in suckling mice, but the resistance of mice increases with age, and induced infections in other mammals and birds were usually transient. It is designated Sindbis virus from the name of the village in which the original mosquitos were caught, and belongs to the same group as the viruses of eastern, western and Venezuelan equine encephalomyelitis and Semliki forest virus. It has been isolated in the Nile delta from mosquitos during three successive summers and once from a young hooded crow (*Corvus corone sardonius*), but was not isolated from large numbers of other blood-sucking insects, mites and ticks collected there or from ticks collected at many places along the Nile valley, including the Sudan. The species of mosquitos from which it was definitely isolated were *C. univittatus*, *C. antennatus* (Becker) and *Anopheles pharoensis* Theo. It was experimentally transmitted to chicks by *C. univittatus* and from chicks to mice as well as from mouse to mouse [**43** 130]. It did not infect *Pseudolynchia canariensis* (Macq.) or *Argas persicus* (Oken) when they were fed on infected chicks or *A. persicus* when it was introduced parenterally by puncture of the body, but *Ornithodoros savignyi* (Aud.) was infected with it by puncture and then transmitted it to suckling mice.

Antibody surveys indicated that the hosts of the virus in the Nile delta included cattle, water buffalo, donkeys, horses, goats, sheep, fowls and wild birds, and that the human immunity rates for the age groups of more and less than 15 years were 34 and 14 per cent. Positive results were also obtained in tests of sera from residents in various parts of the southern Sudan, where the immunity rates in the two age groups averaged 18 and

7 per cent. No information is available on the symptomatology of natural infections.

Work (T. H.), Hurlbut (H. S.) & Taylor (R. M.). **Indigenous Wild Birds of the Nile Delta as potential West Nile Virus circulating Reservoirs.**—*Amer. J. trop. Med. Hyg.* **4** no. 5 pp. 872–888, 1 map, 34 refs. Baltimore, Md., 1955.

West Nile virus has been isolated from man in Uganda [*R.A.E.*, B **31** 203], the Nile Delta [**43** 49] and Israel [*cf.* **43** 19], and a serological survey has shown it to be endemic from the West Nile district of Uganda into the southern Sudan and along the Nile Valley into lower Egypt. Preliminary investigations in Egypt indicated that the infections in the common domestic mammals and fowls during the transmission season would not be sufficient to infect the number of mosquitos necessary to cause widespread infection in a human and animal population with a high proportion of immunity. This conclusion was based both on the relatively low number of non-immune animals available to circulate the virus and on the initial failure to obtain a virus titre in the blood of experimentally infected animals that was adequate to infect mosquitos. It was thought that the common wild birds of the Nile Delta might provide enough non-immunes during the spring nesting season to circulate virus in high enough titre and for long enough to infect vector mosquitos during the summer transmission season, and investigations into this were begun early in 1953. The materials and methods used are described. Serological tests on the six commonest species, namely the house sparrow (*Passer domesticus*), hooded crow (*Corvus corone sardonius*), buff-backed heron (*Bubulcus ibis*), palm dove (*Streptopelia senegalensis*), kestrel (*Falco tinnunculus*) and rock pigeon (*Columba livia*), revealed a significant incidence of neutralising antibodies in all six. The incidence in winter was very high (88 per cent.) in the hooded crow, but the immunity rate was found to diminish in the late spring, probably because of the introduction of the non-immune fledglings into the population. Moreover, the virus had previously been isolated from a hooded crow and two rock pigeons.

Laboratory tests in which birds of all the species except the rock pigeons were used showed that all could be infected by *Culex pipiens* L. or *C. univittatus* Theo. and that these mosquitos and *C. antennatus* (Becker) could transmit the virus to mice from them, while the bird-mosquito-bird cycle was readily demonstrated with the crow, sparrow and heron. The blood-titres and periods of circulation of a given strain of virus varied with the species of bird but were similar in individuals of a species and did not depend on the number of infective bites received, one being as effective as many. Titres were highest and virus circulated longest in the hooded crow, and the sparrow appeared to be the next most favourable host, in terms both of virus circulating capacity and of incidence of neutralising antibody. Rock pigeons, which are abundant and semi-domestic, showed only a 29 per cent. incidence of neutralising antibody in the survey area, but their large numbers and the isolation of the virus from them in nature suggest that they may be of considerable importance.

Chamberlain (R. W.), Kissling (R. E.), Stamm (D. D.) & Sudia (W. D.). **Virus of St. Louis Encephalitis in three Species of Wild Birds.**—*Amer. J. Hyg.* **65** no. 1 pp. 110–118, 15 refs. Baltimore, Md., 1957.

The following is based on the authors' introduction and summary. Considerable evidence has accumulated in the United States to suggest that

St. Louis encephalitis is primarily a disease of birds transmitted by mosquitos, and studies were therefore made on the viraemia pattern and antibody response in three species of wild birds and of the mosquito-bird transmission cycle. English sparrows (*Passer domesticus*), red-winged blackbirds (*Agelaius phoeniceus*) and cowbirds (*Molothrus ater*) were infected with the virus by subcutaneous inoculation and the red-winged blackbird and cowbirds by the bite of infected females of *Culex tarsalis* Coq. also. Viraemias were low, especially in the cowbirds and red-winged blackbirds, undetectable for the most part in blood diluted 1 in 10. This amount of virus in the blood was, however, adequate for infection of normal females of *C. tarsalis* ingesting it. Virus multiplication of over a million-fold in the mosquito was shown. A complete transmission cycle (chicks—*C. tarsalis*—wild birds—*C. tarsalis*—chicks) was accomplished. The antibody response of the birds was weak. The virus was isolated 38 days after infection from gizzard tissue of a cowbird but not from other organs of cowbirds and red-winged blackbirds tested.

Clements (A. N.). **Hormonal Control of Ovary Development in Mosquitoes.** —*J. exp. Biol.* **33** no. 1 pp. 211–223, 7 figs., 28 refs. London, 1956.

The following is virtually the author's summary. A study was made of ovary development in *Culex pipiens* form *molestus* Forsk., an autogenous mosquito not needing food in the adult stage to develop its eggs, and in *C. p. pipiens* L. and other anautogenous mosquitos, which require blood for ovary development. Comparison of the reserves of fully grown larvae of the two forms of *C. pipiens* showed that the autogenous form had a rather larger fat-body, but that the anautogenous form contained sufficient protein reserves to develop a number of eggs. It was considered that autogeny did not depend solely upon the ability to amass extensive reserves [*cf. R.A.E.*, B **22** 127, etc.] but also upon some other physiological mechanism.

Decapitation or ligation at the base of the abdomen prevented ovary development in *molestus* when performed within a few hours of emergence, but decapitation seven or more hours or ligation five or more hours after emergence often failed to prevent ovary development. It is suggested that a gonadotrophic hormone is secreted during this time. Ligation of the abdomen within an hour of feeding on blood appeared to prevent ovary development in *Anopheles stephensi* List. Ovary development occurred in a small proportion of females ligated two or more hours after feeding, and this proportion increased with time [*cf.* **34** 138]. Ligation of the abdomen immediately after blood feeding did not, however, prevent ovary development in *A. maculipennis atroparvus* van Thiel (*labranchiae atroparvus*), *Culex pipiens* form *berbericus* Roub. or *Aëdes aegypti* (L.), even in cases in which the ligature was tied within 2–3 minutes of the start of feeding.

Rafi (S. M.) & Rashid (A.). **Residual Insecticidal Spraying in Sheikhupura District of the Punjab from 1951–1954 and its Results.**—*Pakistan J. Hlth* **5** no. 2 pp. 88–95, 1 map, 6 graphs, 1 ref. Lahore, 1955.

A long-term, intensive programme of Anopheline control was begun in 1951 in some highly malarious rural areas of the Punjab (Pakistan) [*R.A.E.*, B **44** 141], including Sheikhupura, a district of some 1,100 villages. An account is given of the campaign in that district up to the end of 1954 and its cost and results. The numbers of villages treated were 147 in 1951, 380 in 1952, 722 in 1953 and 442 in 1954; DDT (in wettable-powder suspension) was applied in all dwellings and cattle sheds in them at a rate giving a

deposit of 200 mg. per sq. ft. in the first year of treatment and 100 mg. in subsequent years. The parasite rates in children 2–10 years of age from selected villages that were sprayed from 1951 to 1954 were 43·4, 21, 16·7 and 12 per cent., respectively, in the four years and spleen rates fell from 51·2 to 17 per cent., whereas both rates rose from 1952 to 1954 in control villages. Surveys in 1951 were made in June before spraying began. Parasite rates in infants indicated that transmission was not occurring in the sprayed villages in 1952–54, whereas it was occurring in control villages. The average numbers of mosquitos taken daily in November and December at catching stations in dwellings and cattle sheds in sprayed and (in brackets) control villages in 1952, 1953 and 1954 were approximately 0·6 (5·8), 0·9 (12·8) and 1·8 (3·3), and the numbers of *Anopheles* larvae per dip were 2·5 (7), 1 (18·5) and 2·5 (9·5).

Floyd (T. M.) & Hoogstraal (H.). **Isolation of *Salmonella* from Ticks in Egypt.**—*J. Egypt. publ. Hlth Ass.* **31** no. 3 pp. 119–128, 16 refs. Cairo, 1956.

During studies on domestic mammals and fowls as sources of *Salmonella* infections in man in Egypt, examples of the wild fauna were also examined and various serotypes of *Salmonella* were isolated from several native animals, particularly desert rodents. Contaminated food or close contact during confinement, to which the spread of *Salmonella* among domestic animals is commonly attributed, could not explain the infection of herbivorous rodents or insectivorous birds, and the possibility that ticks might be involved in transmission was investigated. References to experimental infection of ticks with *Salmonella* or to the finding of infected ticks in nature are reviewed [*R.A.E.*, B **37** 14, etc.]. During 1953 and 1954, ticks were collected in and near Cairo from the bodies, burrows and resting places of wild and domestic mammals and birds, sorted into pools of 10–15 of the same species from similar collecting sites and cultured. No *Salmonella* was isolated from 90 pools formed of 47 collections of Ixodids from domestic mammals, or from 88 of 98 pools made from 44 collections of Argasids in which nine species were represented, but three out of 22 pools of *Ornithodoros erraticus* (Lucas) from mammal burrows, one of them from a burrow of a hedgehog (*Hemiechinus auritus*) and two from one of a Nile rat (*Arvicanthis niloticus niloticus*), were positive for *S. thompson*, and seven pools of *Argas persicus* Oken from trees where buff-backed herons (*Bubulcus ibis ibis*) were nesting, among 46 from these sites and fowl houses, were positive for *S. typhimurium*.

Papers noticed by Title only.

Atiqur Rahman Ansari (M.). **Synoptic Table for the Determination of Mallophaga infesting the Domestic Fowl** (*Gallus gallus domesticus*). —*Indian J. Ent.* **17** pt. 2 pp. 245–270, 54 figs., 39 refs. New Delhi, 1955.

DeFoliart (G. R.) & Pelton (E. C.). **A Case of human intestinal Myiasis caused by** *Muscina stabulans* **(Fallén)** [in Wyoming].—*Amer. J. trop. Med. Hyg.* **4** no. 5 pp. 953–955, 11 refs. Baltimore, Md., 1955.

Burnett (G. F.), Robinson (J.) & Le Roux (J. G.). **Comparative Trials of D.D.T. and Dieldrin for the Control of the Riverside Tsetse** *Glossina palpalis fuscipes* **(Newst.).**—*E. Afr. agric. J.* **22** no. 3 pp. 142–146, 2 figs., 5 refs. Nairobi, 1957.

Deposits of DDT have been used with considerable success against *Glossina palpalis fuscipes* Newst. in the Nyanza Province of Kenya [*R.A.E.*, B **42** 25–26]. In the standard procedure, Arkotine (a miscible oil containing 15 per cent. w/v technical DDT and a little coumarone resin) is diluted with water to give a spray containing 5 per cent. w/v DDT, which is applied at 15 gals. per mile of river bank. The tests described were designed to give more accurate information on the persistence of the deposit formed, to suggest possible economies and to investigate the effectiveness of a dieldrin deposit. This was produced from Dieldrex 15 (a miscible oil containing 15 per cent. w/v technical dieldrin, but no resin) used at 1·7 or 5 per cent. dieldrin. The weaker spray cost the same as Arkotine at 5 per cent. DDT. The sprays were applied at 15 gals. per mile in mid-November 1955, and ten samples, each consisting of ten smooth leaves of various shrubs for each treatment, were gathered subsequently at intervals. Selection of samples was strictly random as the spray did not necessarily reach all leaves. Effectiveness was assessed biologically by gripping adults of *G. p. fuscipes*, freshly fed or not hungry, in a pair of forceps by the closed wings and allowing them to walk over the test leaves for 15 seconds. They (and controls made to walk on untreated leaves) were then put in clean tubes in a dim light and examined for mortality 24 hours later. At least six leaves in each sample and as many samples as possible were tested, according to the number of flies available. After the biological test, the amount of insecticide on each batch of ten leaves was estimated chemically.

The actual initial deposits of DDT and of dieldrin from the 5 and 1·7 per cent. sprays were 27·6, 41·6 and 10·6 mg. per sq. ft. of leaf, whereas the ratio of the deposit to be expected would be 3:3:1. The DDT and dieldrin deposits fell by one-third in about two and nine days, respectively. The DDT caused 89, 66, 50 and 6 per cent. mortality 3, 5, 8 and 12 days after treatment. The lower concentration of dieldrin gave 87–100 per cent. mortality up to 24 days after treatment, and it and the higher concentration gave 56 and 90 per cent. after 56 days. The more rapid removal of the DDT was attributed to the nature of the deposit. The crystals were present as numerous clumps of needles standing clear of the surface on a sort of varnish, whereas dieldrin was present in small crystals in the holes of a spongy deposit.

It is suggested that the good results obtained in practice with Arkotine used fortnightly may be attributable to milder exposure to sun, wind and rain, longer contact and possibly better persistence on twigs than on leaves. Even if Arkotine remains highly lethal for only two or three days, it may kill nearly all the flies present at the time of spraying, those emerging later being killed by the next application before they can breed. The success achieved suggests either that the kill within two or three days of application was nearly complete or that the DDT was more persistent than would be expected from the experimental results. The latter indicate that one application of 1·7 per cent. dieldrin is effective at least three weeks longer than one of 5 per cent. DDT, so that two sprayings with 1·7 per cent. dieldrin five weeks apart should be as effective as four of 5 per cent. DDT two weeks apart. Since, however, the latter schedule, with a total lethal period of only seven weeks, has been effective in the past, the interval between the two dieldrin applications could be reduced to four weeks, giving a lethal period of at least eight weeks and less chance of a falling-off in kill between the two treatments. Alternatively, one application of 5 per cent.

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dieldrin might be as effective and would save labour, but the safety margin might be less, owing to the complete loss of effectiveness of lightly treated areas after two months. It can be shown by calculations in which the life-cycle of the fly is considered that, at normal local temperatures, four treatments with Arkotine would be as effective at intervals of three as at intervals of two weeks, and the chance of failure would be reduced by the prolongation of the total period covered. If the kill at each application approached 100 per cent., as is suggested by past success, three treatments only at intervals of three weeks would be sufficient.

Allred (D. M.) & Roscoe (E. J.). **Life History of the Tick** *Dermacentor parumapertus* **in Utah.**—*J. Parasit.* **42** no. 5 pp. 516–522, 3 figs., 12 refs. Lancaster, Pa., 1956.

Roscoe (E. J.). **A Rabbit Tick,** *Dermacentor parumapertus*, **attached to Man.**—*T. c.* p. 527.

The following is almost entirely based on the introduction and summary of the first paper. *Dermacentor parumapertus* Neum. is widely distributed in the Great Basin area in Utah, where it is the commonest tick at the lower altitudes. The larvae and nymphs occur on 12 or more kinds of rodents, in particular on kangaroo rats (*Dipodomys*), but the adults are abundant only on a hare (*Lepus californicus deserticola*). As this tick is known to harbour in nature the causal agents of tularaemia and Colorado tick fever and a rickettsia similar to the one that causes spotted fever, and has been shown experimentally to transmit Rocky Mountain spotted fever and tularaemia, it may be of great importance in maintaining epizootics in Utah. The results are given of local studies on some aspects of its bionomics. Engorged females collected from hares began to oviposit after 7–20 and 5–12 days when kept at room temperature and relative humidities of 81 and 95 per cent., respectively. Individual females laid 30–6,587 eggs, and there was a direct correlation between the degree of engorgement and the number of eggs laid. The incubation periods were 28–37 days at 81 per cent. humidity and 26–36 days at 95 per cent. The larvae were placed on kangaroo rats 9–44 days after hatching, and the nymphs 15–33 days after the moult. They readily attached themselves, and the periods required for engorgement, and those between dropping and moulting were 4–13 and 7–16 days for larvae and 6–14 and 17–28 days for nymphs. Many larvae and nymphs were eaten by the hosts. Little is known of the feeding habits of the adults.

It is stated in the second paper that the only published record of man as a host of *D. parumapertus* is that of Neumann for the type specimens, and workers in Utah with whom the author was associated had not been attacked by it, although they had handled thousands of host animals and come into close contact with hundreds of thousands of the ticks over a period of three years. A single male was, however, found attached to the author's thigh on an evening in June 1955. The tick was forcibly removed, and no effects were noted other than a slight irritation at the site of attachment for about two hours.

Hussein (A. G.). **Changes in the Epidemiology of Plague in Egypt, 1899–1951.**—*Bull. World Hlth Org.* **13** no. 1 pp. 27–48, 4 figs., 7 refs. Geneva, 1955. (With a Summary in French.)

The epidemiology of plague in Egypt from 1899, when the third pandemic reached Alexandria, until 1951 is discussed. The disease, from which the country had been free for half a century, was first reported in Alexandria

and Port Said and then spread inland with increasing speed, reaching its maximum in 1908–12. In contrast with the position in previous epidemics, it was more prevalent in Upper than in Lower Egypt. By 1939, the whole of Lower Egypt was free of the disease, which, however, persisted in endemo-epidemic form in Upper Egypt until 1941. The pandemic was much less severe in Egypt than previous epidemics had been, as exemplified by records of 10,131 deaths from plague for the whole country between 1899 and 1928 as compared with more than three times as many in less than six months in Cairo alone in 1835. The main reasons are thought to be the progressive supplanting of *Rattus rattus* by *R. norvegicus*, progress in environmental sanitation, housing and town planning, improved quarantine services and international co-operation, and a steady natural decrease in the numbers of fleas on rats. Details of the number of rats (*R. norvegicus*, *R. rattus* and *Acomys cahirinus*) caught in Alexandria and the numbers of *Xenopsylla cheopis* (Roths.) and *Leptopsylla musculi* (Dugès) per rat are given for the years 1937–45. Details are also given of a scheme introduced in 1941 for the control of rats in river and canal craft in order to prevent the spread of plague inland from the ports. No case of plague was reported inland from 1941 to 1945, despite an outbreak during that time in the Suez Canal Zone.

In 1946, an epidemic broke out in Alexandria, where no case had been reported since 1936. It reached a peak in June and then declined until 9th September, when it ended for the year. There were 124 cases with 34 deaths in 1946 and 15 cases with five deaths in 1947, after which no more cases occurred. The outbreak was attributed to the use for imports of a port previously used for export only, the increase of harbourage for rats due to bombing and a defective sewage-disposal system giving rats easy access to houses. Control measures included trapping and poisoning of rats throughout the town, fumigation of all river craft leaving Alexandria and flea control with DDT. In 1946 and 1947, infected houses were treated with 5 per cent. DDT solution, the inhabitants of infected areas and their bedding were dusted with 10 per cent. DDT powder, and rat burrows in the same areas were dusted with the powder and the holes then filled in. Moreover, the whole population of the country was dusted periodically with DDT for the control of lice [*Pediculus humanus* L.] as part of a campaign against an epidemic of relapsing fever, and this was done in such a way that the powder fell to the floors and controlled fleas. From 1950 onwards, BHC (Gammexane) was also used because of a shortage of DDT. The slow, natural decrease in numbers of fleas on rats that had been in progress until 1946 was accelerated sharply. Periodical dusting of all rat burrows and the walls and floors of all stores and warehouses in port areas became compulsory in 1950. After the end of 1947, no further cases of plague had been notified in Egypt up to the end of 1954.

Kartman (L.) & Lonergan (R. P.). **Wild-rodent-flea Control in rural Areas of an enzootic Plague Region in Hawaii. A preliminary Investigation of Methods.**—*Bull. World Hlth Org.* **13** no. 1 pp. 49–68, 12 figs., 24 refs. Geneva, 1955. (With a Summary in French.)

Preliminary field tests were carried out in 1952–53, to develop methods for controlling fleas on field rats in the district (Hamakua) of the Island of Hawaii in which plague occurs in enzootic form [*cf. R.A.E.*, B **35** 185, etc.]. The district is described. The number of fleas found on the rats is low, but it is adequate to enable the plague to become epizootic when meteorological conditions are favourable. Plague control depends on reducing the flea index below the level at which epizootics can develop.

Indiscriminate dispersal of DDT was impracticable, because of the high rainfall and danger to beneficial insects, and few rodent burrows could be located for direct treatment, because of the bush vegetation. It appeared that the rats themselves should be used to make contact with the insecticide and disseminate it, and DDT bait-boxes were therefore investigated. Of several types designed for the study, two of which are described, a metal hood-type box was the most promising, as it is simple, cheap and easy to transport and maintain in the field and it attracted all species of field rats in the area (*Rattus hawaiiensis*, *R. rattus* and its subspecies and *R. norvegicus*). It consisted of a tray and hood or tunnel of galvanised iron or other metal with a dish of bait in the middle and a bag of 10 per cent. DDT in pyrophyllite hung at either end, so that the rats brushed against it and sprinkled themselves with the dust as they entered and left the box [*cf.* **35** 192].

In an initial experiment, carried out in February and March 1952, rats were trapped in 200 traps, freed from ectoparasites, marked, released and trapped again. The rats from part of the experimental area were dusted with 10 per cent. DDT powder (about 3 gm. per rat) each time they were caught, and the others served as controls. The percentages of rats infested by fleas (*Xenopsylla cheopis* (Roths.) and *X. vexabilis hawaiiensis* Jord.) and the numbers of fleas per rat were both smaller in the treated than the untreated rats, and the differences were greater for *R. hawaiiensis* than *R. rattus* (the only species recaptured). They were not sufficient for statistical significance, but suggested that the bait-boxes might be of value.

Flea control in an area in which the bait-boxes were used was estimated, as in the initial experiment, from the infestation of trapped rats by the two species of *Xenopsylla*. The bait-boxes were spaced about 250 ft. apart. Significant control of fleas on *R. rattus*, but not on *R. norvegicus*, was obtained in July–October 1952, when the bait-boxes were of a type that did not attract *R. hawaiiensis*. In 1953, when the hood-type boxes were used from 3rd March to 24th April, flea control was significant on *R. hawaiiensis* and, because this was the predominant species, on all rats, but it was not significant on *R. rattus* or *R. norvegicus*, although their infestations were reduced. Other experiments indicated that the difference in degree of flea control on *R. rattus* in the two years was not due to the change in the type of bait-box.

Nine nests of rats from the treated area and 14 from the control area were examined in March–May 1953, and fleas were found in none of the former and all of the latter. It thus appeared that the rats carried the DDT to their nests, and this was confirmed by chemical analysis of one of them.

MILLER (D.). **Bibliography of New Zealand Entomology 1775–1952 (with Annotations).**—*Bull. N.Z. Dep. sci. industr. Res.* no. 120, 10 × 6¼ ins., xxiv + 492 pp., 1 map. [Wellington, N.Z.] 1956. Price £1.

The main section of this bibliography is arranged under authors and comprises some 3,400 references dating from the first record of insects in New Zealand by Fabricius in 1775 down to 1952, though a few from 1953 are also included. The species or groups of insects concerned are indicated in most cases, and libraries in New Zealand or elsewhere in which the originals are available are listed. This is followed by a subject index in which references to the main list are classified under 11 main headings with subdivisions. One of the subdivisions under the heading of applied entomology is a list of insect pests, with their New Zealand references.

Green (H. L.) & Lane (W. R.). **Particulate Clouds: Dusts, Smokes and Mists. Their Physics and Physical Chemistry and Industrial and Environmental Aspects.**—10 × 6¼ ins., xix + 425 [+1] pp., 8 pls., 107 figs., many refs. London, E. & F. N. Spon, Ltd., 1957. Price £3 10*s*.

Particulate clouds include any type of suspension of particles in a gaseous medium, regardless of the nature of the suspended material, but excluding particles so large that they settle rapidly; the chief forms are dusts, smokes and mists. In the first part of this book, the authors review basic information on the physics and physical chemistry of such systems, and in the second, their industrial and environmental aspects. Their use in the application of insecticides is the subject of the final section (pp. 404–410), which includes brief discussions of the influence of droplet size on the effectiveness of sprays and aerosols, the main types of aerosol generators, the generation of insecticidal smokes, and the application of sprays and mists.

Livadas (G.). **Resistance of Anophelines to chlorinated Insecticides in Greece.**—*Mosq. News* **15** no. 2 pp. 67–71, 5 graphs, 9 refs. Albany, N. Y., 1955.

The vectors of malaria in Greece are members of the complex of *Anopheles maculipennis* Mg. (referred to in this paper as *sacharovi* Favr and *maculipennis* [*cf. R.A.E.*, B **36** 39]) and *A. superpictus* Grassi. A generalised campaign for their control by DDT was begun in 1946 [**39** 109, 132], but they were reported to have acquired resistance to it in some parts of the country in 1951. In the following year, it was ascertained experimentally that *sacharovi* had become resistant to DDT and BHC in two villages in the Scala-Laconia area [**42** 32], and also to chlordane in a third. A survey in 1953 and 1954 showed that this mosquito was little affected, if at all, by DDT house spraying in other areas, or even by spraying two or three times in the same season with various chlorinated insecticides in turn, and that *superpictus* and *maculipennis* were also resistant to these insecticides. The development of resistance by the Anophelines was followed by an increase in malaria in some areas, and sometimes by local epidemics.

Investigations were also made in Scala-Laconia in 1953 and 1954 on the effectiveness of chlorinated insecticides against *sacharovi* in experimentally sprayed stables. The density of the mosquitos in a stable sprayed with DDT at 2 gm. per sq. metre was high in the first five-day period after spraying and rose quickly to levels observed in unsprayed stables during the subsequent two five-day periods. Mortalities in 24 hours of mosquitos caught in the stable in the first, second and third five-day periods after spraying were 35·7, 23·7 and 23·9 per cent., respectively. Their density in a stable sprayed with 1,500 mg. chlordane per sq. metre declined considerably at first, but rose abruptly during the second five-day period and then fluctuated as it did in the control stable. Mortalities in cages of examples caught in the chlordane-treated and the control stable were about the same from the first. Dieldrin was more effective, but even so some mosquitos were caught in the first five-day period in a stable treated with 400 mg. dieldrin per sq. metre and density increased in the fourth period. Mortality in cages was high in the first two periods, but it declined abruptly thereafter. A combination of 320 mg. Diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] and 250 mg. dieldrin per sq. metre was better. Mortality was complete in 24 hours in the cages among

mosquitos caught during the first five days after treatment, and 86·9 per cent. during the second five-day period, but it declined abruptly thereafter.

Tests in which DDT was applied topically to the mosquitos showed that the LD90 for *sacharovi* had risen from 0·36 μg. in 1953 to 0·48 μg. in 1954 at Elos (Scala) and was 0·19 μg. in 1954 in Agoulinitsa (Elia) where epidemiological observation had shown clear resistance to DDT, chlordane and BHC. The LD90 for *maculipennis* was 0·14 μg. in a locality of Crete in which house spraying by the malaria control service was discontinued in 1951 but is said to be continued privately from time to time. Tests in which the mosquitos were confined on paper impregnated with DDT also showed that the resistance of *sacharovi* was much greater at a village near Elos than at Agoulinitsa.

Thompson (R. P.) & Brown (A. W. A.). **The Attractiveness of Human Sweat to Mosquitoes and the Role of Carbon Dioxide.**—*Mosq. News* **15** no. 2 pp. 80–84, 11 refs. Albany, N. Y., 1955.

It was found in field experiments with robots that sweat-soaked clothing is almost twice as attractive to Canadian species of *Aëdes* as equally moist clean clothing [*R.A.E.*, B **40** 39], and olfactometer tests have shown that the vapour from an aqueous solution of human sebaceous sweat can attract about 40 per cent. more females of *A. aegypti* (L.) than water vapour alone [**39** 189–190]. Human sweat is comparable to a weak solution of sodium chloride in water and contains practically all the non-colloidal constituents of blood plasma. It is largely composed of sudor, but, except on the palms of the hands and soles of the feet, the sudor is mixed with sebum, the proportion of sebum being highest in sweat from the armpits and other parts of the body in which the sebaceous glands are most abundant, and very low in sweat from the forehead. Sebum contains lower fatty acids, higher primary alcohol esters and cholesterol, in addition to albumins and inorganic salts. Experiments are described in which sweat from the armpits and sweat from the forehead of Caucasian men were tested separately to determine whether they evoked the same response in females of *A. aegypti*.

The following is based on the authors' conclusions. The armpit sweat proved significantly attractive to the mosquitos when tested in the olfactometer at sufficient concentration. The forehead sweat was not attractive in the olfactometer. The attractiveness of moist cloth was not increased by the addition of armpit sweat. It is unlikely that carbon dioxide is responsible for the attractiveness of human sweat in the olfactometer, as its addition to or removal from armpit sweat did not alter the attractiveness of the sweat, nor did the addition of carbon dioxide in the proportion found in sweat increase the attractiveness of distilled water. However, the addition of carbon dioxide to water-soaked cloth significantly increased its attractiveness. The attractiveness of armpit sweat was decreased by treatment to release volatile acids present in the sebaceous part and normally held by esterification, but was not affected by the release of any volatile bases present.

Blanton (F. S.), Galindo (P.) & Peyton (E. L.). **Report of a Three Year Light Trap Survey for Biting Diptera in Panama.**—*Mosq. News* **15** no. 2 pp. 90–93. Albany, N. Y., 1955.

A description is given of the way in which surveys were made in 1951–53 to establish the distribution in the Panama Canal Zone and the Republic of Panama of blood-sucking Diptera that could be attracted to light.

Standard New Jersey light-traps [*R.A.E.*, B **23** 151; **31** 195] and traps of the Shannon type [*cf.* **27** 193] in which insects attracted by a light near the top of the hanging cheese-cloth tent were caught in a suction tube, were operated at 138 different places on a total of 454 nights. Most of the surveys were on the existing road system, but several were carried out near the Colombian border in the Darien Province, in an area that was reached by boat, and another large series near Almirante in the Province of Bocas del Toro, principally at a station in deep tropical rain forest at an elevation of about 600 ft. The total numbers of mosquitos, *Culicoides* and *Phlebotomus* taken by the end of August 1953 were 240,573, 425,141 and 39,023.

Merrell (D. J.) & Underhill (J. C.). **Selection for DDT Resistance in inbred, laboratory and wild Stocks of** *Drosophila melanogaster*.—*J. econ. Ent.* **49** no. 3 pp. 300–306, 29 refs. Menasha, Wis., 1956.

The following is based on the authors' summary. The development of resistance to DDT was studied in populations of *Drosophila melanogaster* Mg. derived from inbred, laboratory and wild stocks. Almost all the wild stocks and one of the laboratory stocks developed resistance, but the remaining six laboratory stocks and the two inbred ones did not, indicating that the ability of a population to become resistant is related to the amount of genetic variability in the original population. Hybrid populations obtained by crossing inbred laboratory stocks did not become more resistant, which indicates either that the crosses produced little increase in variability and hence nothing new for selection to act upon, or that the variability was such that the new combinations of genes conferred no greater resistance than the old. Since the adults used to form the hybrid populations were of diverse origin and hence unlikely to be genetically identical, the second explanation seems more probable. The development of resistance was directly related to the intensity of the selection pressure, the higher concentrations of DDT being more effective in producing increased resistance. Resistance usually increased most rapidly during the first few months of selection. The stocks tended to have different levels of resistance, for some of the controls differed from each other, and the resistant stocks also differed from each other as well as from their controls. The level of resistance in the populations did not remain static, and three populations that had become more resistant later declined in resistance, despite continued exposure to DDT [*cf. R.A.E.*, B **42** 157].

The implications of the results are discussed in relation to the genetic mechanisms controlling resistance, the question of reversion to susceptibility on termination of exposure to DDT, and the amount of morphological and physiological change to be expected in association with resistance.

Rai (L.), Afifi (S. E. D.), Fryer (H. C.) & Roan (C. C.). **The Effects of different Temperatures and Piperonyl Butoxide on the Action of Malathion on susceptible and DDT-resistant Strains of House Flies.**—*J. econ. Ent.* **49** no. 3 pp. 307–310, 11 refs. Menasha, Wis., 1956.

Hoffman, Hopkins & Linquist [*R.A.E.*, B **42** 187–188] found that piperonyl butoxide had a synergistic action with several phosphorus insecticides but not with malathion, when these were tested as deposits against a DDT-resistant strain of *Musca domestica* L. The authors have investigated the action of piperonyl butoxide and three phosphorus compounds, malathion, Diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] and Bayer L 13/59 [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate] on DDT-resistant and normally susceptible strains of *M.*

domestica and the nature of the temperature coefficients of such combinations. They observed a small but significant difference in the tolerance of the two strains to the insecticides both alone and in combination with piperonyl butoxide. The latter had significant synergistic effect with Diazinon and Bayer L 13/59, but a pronounced antagonistic effect with malathion. The results of investigations of this antagonism are given in the present paper. The LD50's of DDT determined by topical application were 3 and more than 600 μg. per gm. flies for the susceptible and resistant strains, respectively. The flies were reared at 80 ± 2°F. and conditioned to the test temperature (63, 70, 75 or 82°F.) for 24 hours before treatment. Only males four days old were used. The malathion was 99·6 per cent. pure and the piperonyl butoxide was of technical grade. Solutions of ten parts piperonyl butoxide and one part malathion in acetone were applied topically.

All data were analysed statistically. They showed significant differences in the effects of malathion alone and with piperonyl butoxide, in the responses of the two strains of flies, and in the effects of temperature. The interaction between strain and treatment was significant, but the interactions between strain and temperature and between treatment and temperature were not. The LD50's, in μg. per gm. of flies, of malathion alone and (in brackets) with piperonyl butoxide for the DDT-resistant and susceptible strains were, respectively, 30·12 (50·79) and 18·8 (34·66) at 63°F., 26·44 (38·56) and 17·57 (24·54) at 70°F., 20·75 (30·71) and 12·87 (18·83) at 75°F., and 19·56 (34·66) and 13·39 (19·43) at 82°F. The data obtained indicated that the general mechanisms of intoxication differ markedly for the two treatments.

Afifi (S. E. D.) & Knutson (H.). **Reproductive Potential, Longevity, and Weight of House Flies which survived one insecticidal Treatment.**—*J. econ. Ent.* **49** no. 3 pp. 310–313, 6 refs. Menasha, Wis., 1956.

The following is based on the authors' summary. This study was concerned with the effect of a single insecticide treatment on the biology, through one treated and three untreated generations, of house-flies [*Musca domestica* L.] of a strain with no previous history of exposure to insecticide. Flies were treated topically when 3–4 days old with dieldrin at a concentration to produce 60–90 per cent. mortality within two days. At the end of this time, survivors were allowed to mate. These treated parent flies and the successive untreated filial generations reared from them are referred to as TP, TF_1, TF_2 and TF_3 and the corresponding controls as UP, UF_1, UF_2 and UF_3; and the numbers of their offspring are expressed as the average numbers of adult flies resulting from the eggs laid per 100 females. The TP females produced 2,803 offspring in the first week after mating and 5,594 in all, whereas the UP females produced 3,061 and 4,795. The difference in the first week is attributed to the direct effect of the toxicant. The difference between the final totals was not significant, but this does not necessarily preclude a significant difference in nature, because of the enforced postponement of mating for 5–6 days (a substantial part of the normal reproductive period) in both groups, and the initial lag after mating of nearly a week in productivity in the dieldrin-treated flies. The TF_1 and UF_1 flies produced 18,361 and 10,816 progeny, respectively, during the first 13 days after initial mating. They were then killed by a laboratory accident, but would presumably not have laid many more eggs, and the 69·2 per cent. higher production by the T flies was significant. The TF_2 and UF_2 flies produced 16,688 and 15,268 offspring, and the TF_3 and UF_3 flies produced 8,569 and 9,716. Neither difference was significant, indicating a reversion to the normal rate of reproduction in the T flies.

The life spans and oviposition periods were both slightly longer in the TP and TF_2 females than in their respective controls, but the differences were not significant. Average weight at death was also greater in these females than in their controls, the differences being significant for the TF_2 flies and almost significant for the TP flies. A linear correlation was found between the weight of the TP females and the number of progeny they produced. However, this correlation was not significant in the UP females or in the filial generations of either group. There were no significant correlations between length of life and average weight or between length of life and number of progeny. As a consequence of the results obtained, field studies are being carried out to determine if differences may persist when exposure to insecticide is repeated.

Lea (A. O.), Dimond (J. B.) & DeLong (D. M.). **A chemically defined Medium for rearing** *Aedes aegypti* **Larvae.**—*J. econ. Ent.* **49** no. 3 pp. 313–315, 7 refs. Menasha, Wis., 1956.

The following is virtually the authors' summary. A chemically defined medium is described in which the larvae of *Aëdes aegypti* (L.) can be reared aseptically to adults. The medium consisted of a mixture of amino acids, a salt mixture, glucose, cholesterol, ribonucleic acid, and a vitamin mixture dissolved or suspended in water. Agar was added to the medium before sterilisation, and on cooling, the agar with the nutrients was solidified in the bottom of small rearing bottles. Sterile water was added on top of the agar medium and surface-sterilised eggs introduced aseptically into the water. The larvae fed on the nutrient agar in the bottom of the bottle and pupated in slightly less than two weeks. If the pupae were transferred to sterile water, the adults emerged successfully and appeared normal.

DeFoliart (G. R.). **Fly Control in Wyoming Barns.**—*J. econ. Ent.* **49** no. 3 pp. 341–344, 6 refs. Menasha, Wis., 1956.

Tests in 1953 at comparatively low altitudes in south-eastern Wyoming indicated that control of house-flies (*Musca domestica* L.) is not complicated by any high degree of resistance to insecticides, and the same is probably the case in much of the mountainous western part of the State where house-flies have a comparatively short season. Deposits from sprays of 2 per cent. methoxy-DDT (methoxychlor) in wettable-powder suspension gave up to six weeks' control (to the end of the season) in dairy barns at an altitude of 4,100 ft. and eight weeks' control to the end of the season further west at Laramie at an altitude of 7,200 ft. Methoxy-DDT or γ BHC (lindane) had been used in most of these barns for several years. Methoxy-DDT at 0·5 per cent. gave satisfactory control for only two weeks or less but killed a great many flies for longer. Results in 1955 were less good but still satisfactory. Appreciable numbers of flies, including *M. domestica*, are often seen in barns in early summer dying from contact with deposits of insecticides applied in previous years. R. D. Ritchie in unpublished observations found only moderate resistance to DDT and chlordane in a laboratory study of Laramie house-flies.

Although control with methoxy-DDT in dairy barns still seemed satisfactory, the possibility that phosphorus compounds might be more effective was investigated. Fly control is not ordinarily necessary until late June or early July. *Muscina stabulans* (Fall.) and blowflies, mainly *Lucilia* (*Phaenicia*) *sericata* (Mg.) form most of the population early in the season. *Musca domestica* appears early in July, but it is not dominant in the

population until late July or early August. *Stomoxys calcitrans* (L.) may be carried into barns by cows. Sprays of Diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] at 1 per cent., methoxy-DDT at 2 per cent., and malathion at 1·25 per cent. were effective in that order in controlling flies when applied to the point of run-off to walls, ceilings and stanchions of dairy barns in the south-east of the State in July or August 1955. Diazinon gave control to the end of the season, a period ranging from 5 to 11 weeks. Methoxy-DDT gave control for three weeks in these tests, and for nine weeks (to the end of the season) in one barn at Laramie. Malathion gave control for only 1–2 weeks in two barns, in one of which it was used with the addition of 2 lb. sugar per 10 U.S. gals. spray. Varnish baits, prepared by dissolving 1–5 gm. Bayer L 13/59 [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate] in 4 oz. water and mixing the solution with 1 U.S. pint maize syrup applied to areas where flies tend to congregate, were tested in 1954 as well as 1955. They gave good to fair control for about three weeks in dairies and were considered satisfactory, though less effective than the sprays of Diazinon or methoxy-DDT. They rapidly attracted blowflies and house-flies even when close to molasses-sweetened feed and were effective for short periods even where sanitation was poor, but were not entirely satisfactory in buildings in which cows were milked or calves were housed, because they did not control *S. calcitrans* and the sites on which they could be applied were limited owing to the danger of their being licked off by calves or of dead flies accumulating in feed troughs and water containers.

Hoffman (R. A.). **Control of the Northern Fowl Mite and two Species of Lice on Poultry.**—*J. econ. Ent.* **49** no. 3 pp. 347–349, 8 refs. Menasha, Wis., 1956.

An account is given of experiments carried out to evaluate treatments suitable for application to fowls under the conditions in which the flocks are kept in Oregon, particularly in winter when dusts are preferable to sprays. The following is mainly based on the author's summary of these. Control of *Ornithonyssus* (*Bdellonyssus*) *sylviarum* (C. & F.) on white leghorn hens was effected in the laboratory by hand-dusting at 5 gm. per bird with 1 per cent. γ BHC (lindane) or 5 per cent. lauseto neu [p-chlorophenyl chloromethyl sulphone], Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate], Bayer L 13/59 [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate], Am. Cyanamid 4124 [O,O-dimethyl O-2-chloro-4-nitrophenyl phosphorothioate], Chlorthion [O,O-dimethyl O-3-chloro-4-nitrophenyl phosphorothioate] or malathion. DDT was ineffective at 5 per cent. Bayer L 13/59, Chlorthion and malathion also gave good control when a 2·5 per cent. dust was sprinkled over the backs of the birds at 3 gm. per bird. Dusts containing 0·5 per cent. or more of malathion applied by the sprinkle technique gave complete control of *Menacanthus stramineus* (Nitzsch) and *Menopon gallinae* (L.) on fowls kept in individual cages, but a 0·25 per cent. dust was less effective.

A 4 per cent. malathion dust applied with a rotary duster to flocks on wire at a rate of 4 gm. per bird gave practical control of *O. sylviarum* for at least 30 days, and malathion as an emulsion spray at 0·25–0·5 per cent. applied at 25 ml. per bird gave excellent control. Treatment of sawdust litter with malathion dusts for the control of *O. sylviarum* resulted in 80–100 per cent. initial reduction in infestation of the fowls kept on it when 1 lb. of 4 per cent. dust was applied to floor areas of 40–200 sq. ft. However, lasting effectiveness was erratic, and only the highest rate could be considered an effective one-application treatment. Dusts of γ BHC at

1 per cent. and malathion at 4 per cent. were completely effective against *Menacanthus stramineus* and *Menopon gallinae* when applied to litter at 1 lb. dust per 150 sq. ft. A 4 per cent. Chlorthion dust was slightly less effective and 4 per cent. DDT gave no control at 1 lb. and only partial control at 2 lb. per 150 sq. ft.

DeFoliart (G. R.). **Dusting for Horn Fly Control on Beef Herds.**—*J. econ. Ent.* **49** no. 3 p. 393, 1 fig., 2 refs. Menasha, Wis., 1956.

Lindquist & Hoffman obtained good control of *Siphona irritans* (L.) on dairy cattle by hand application of methoxy-DDT (methoxychlor) as a 50 per cent. wettable powder used dry [*R.A.E.*, B **42** 189] and recommended the method for small dairy herds. Tests in 1955 in Wyoming indicated that dry wettable powders might also be useful on large herds of beef cattle, especially where control with rubbing devices [**42** 188, etc.] had not been satisfactory. The powder was applied with a hand-operated rotary duster. In some tests, cattle were crowded into a small corral and the operator stood on the railings and applied the dust to their backs, but it was preferable to use a large corral and walk about among the cattle to dust them. By this method, cattle can be treated in remote corrals difficult to reach with spraying equipment and water. Cattle could be treated at the rate of three per minute in small enclosures, including the time used to pen and disperse them. Less time was needed with a large corral. The author had previously found that 0·5 per cent. DDT spray at 2 U.S. quarts (or 9 gm. DDT) per animal gave control of *S. irritans* for an average of 26·5 days [*cf.* **43** 24]. In the dusting tests, 19–26 gm. 50 per cent. wettable powder (9–13 gm. DDT) per animal gave control (25 or less flies per animal) for 23·5 days. A 1 per cent. dieldrin dust at 12–19 gm. per animal gave an average of 15 days' control in three tests and a 25 per cent. dieldrin wettable powder at 17 gm. per animal also gave 15 days' control in one test. The method appears to be as rapid and economical as spraying and about as effective, and involves only a small outlay for equipment.

Knapp (S. E.), Farinacci (C. J.), Herbert jr. (C. M.) & Saenger (E. L.). **A Method for Labeling the Lone Star Tick with a Radioactive Indicator (P^{32}).**—*J. econ. Ent.* **49** no. 3 pp. 393–395, 2 figs., 6 refs. Menasha, Wis., 1956.

About 1,300 ticks (*Amblyomma americanum* (L.)) were made radioactive by submersion in a solution containing ^{32}P as sodium dihydrogen phosphate and having a specific activity of 10 μc. per ml. The ticks (in lots of up to 200) were confined in a Büchner funnel by a disk of 36-mesh brass wire, with a ¼-inch hole in the centre through which they were inserted. The solution was poured into the funnel, allowed to stand for one minute and then drawn off. This procedure was carried out three times with the same solution. The ticks were then transferred to clean petri dishes. They were measured for uptake and retention of ^{32}P with a mica end-window Geiger-Muller tube attached to an autoscaler. They were held in place individually under the window and ½ inch from it in a rubber retaining ring with a lens-paper cover on a stainless steel planchet. The mean counts per minute for lots of about 25 individuals treated 14 days before in solution containing no wetting agent were 278 for males and 397 for females. Addition of a wetting agent to the solution [*cf. R.A.E.*, B **41** 108; A **43** 327] did not increase uptake or retention of ^{32}P but substantially reduced survival of female ticks. The use of wetting agents is therefore not recommended.

Raun (E. S.) & Casey (D. J.). **A Comparison of Back Rubber Formulations for controlling Horn and Stable Flies in Iowa.**—*J. econ. Ent.* **49** no. 3 pp. 395–397, 1 fig., 1 ref. Menasha, Wis., 1956.

The following is based on the authors' summary. During a period of five weeks in the summer of 1955, fly counts were made on 13 herds of cattle in Iowa to determine the effectiveness of five insecticide formulations in the control of *Siphona irritans* (L.) and *Stomoxys calcitrans* (L.). The formulations were diluted with fuel oil and applied to the burlap wrappings of two-post cable-type back rubbers, with a hanging cable between the posts and a taut cable stretched from the top of one post to the ground [*cf. R.A.E.*, B **40** 131; **43** 118], in the pastures of ten of the 13 observation herds. Each formulation was tested on two herds. All gave almost complete control of *Siphona* on the cattle for the whole observation period of five weeks. None controlled *Stomoxys* to any significant degree. The five diluted materials as applied to the back rubbers contained 4 per cent. DDT or methoxy-DDT (methoxychlor) alone or with the addition of 8 and 10 per cent. butoxypolypropylene glycol, respectively, and 5 per cent. methoxy-DDT with 50 per cent. butoxypolypropylene glycol.

Hansens (E. J.). **Granulated Insecticides against Greenhead** (*Tabanus*) **Larvae in the Salt Marsh.**—*J. econ. Ent.* **49** no. 3 pp. 401–403, 3 refs. Menasha, Wis., 1956.

It has not been possible to control *Tabanus nigrovittatus* Macq. in New Jersey by the use of DDT against the adults [*R.A.E.*, B **38** 153] because the amount needed would harm other life. Tests were therefore made in 1951–54 of insecticides applied to salt-marsh areas in granular formulations for the control of the larvae. The carrier for all formulations was ground tobacco stems, and the rate of application was 10 lb. per acre. Dieldrin applied from aircraft at a concentration of 5 per cent. eliminated the larvae from the treated marsh for two years but did serious damage to other animal life. Applied at 1 or 2 per cent., with a hand duster, or at 2 per cent. from aircraft, it did much less damage and reduced populations of *T. nigrovittatus* for at least a year. Application from the ground was less satisfactory than application from the air. DDT at 10 per cent., aldrin at 2 per cent., and BHC at 2 per cent. γ isomer, all gave good initial kills but had no lasting effectiveness. Populations were estimated by clearing the vegetation from representative areas and sprinkling an emulsion containing 0·1 per cent. γ BHC (lindane) at 2 U.S. quarts per sq. yard to bring the larvae to the surface. Nearly all came up within an hour.

Goodwin (W. J.). **Toxicity of Diazinon Vapors to Horn Flies.**—*J. econ. Ent.* **49** no. 3 pp. 406–407, 4 refs. Menasha, Wis., 1956.

The following is largely based on the author's summary. Observations in South Carolina on populations of *Siphona irritans* (L.) on cows milked in barns showed that they were considerably reduced when the barns had been sprayed with Diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] as a 0·5 per cent. suspension of wettable powder at 1 U.S. gal. per 250 sq. ft. As *S. irritans* stays on the host almost constantly, a fumigating effect was indicated [*cf. R.A.E.*, B **45** 36]. The temperature of the barns was 20–35°C. [68–95°F.], and the vapour pressure of Diazinon is 0·00014 mm. mercury at 20°C. Laboratory and field experiments carried out late in the season proved that the vapours of Diazinon sprayed as a 0·5 per cent. wettable-powder suspension were highly toxic to

S. irritans. Exposure to the vapours for three hours 21 days after application gave complete kill under laboratory conditions, and the average numbers of *Siphona* per cow on cows that spent only 30 minutes daily (two milking periods of 15 minutes each) in a barn that was sprayed at 1 U.S. gal. per 360 sq. ft. were 68 immediately before the application and 9, 18 and 65 one, eight and 13 days after it.

Goodwin (W. J.). **Control of Horn Flies on Cattle with treated Rubbing Devices.**—*J. econ. Ent.* **49** no. 3 pp. 407–408, 8 refs. Menasha, Wis., 1956.

Effective control of *Siphona irritans* (L.) on beef cattle and dairy heifers was obtained in South Carolina with treated rubbing devices of the tight-cable inverted V or louse type [*R.A.E.*, B **43** 118; **45** 79], installed in situations frequented by the animals. The percentage reductions in numbers of *S. irritans* effected by the various formulations tested were 98·7 and 95·9 by 5 per cent. DDT with and without 10 per cent. butoxypolypropylene glycol, 99·8 by 5 per cent. ethyl-DDD (Perthane [1,1-bis(p-ethylphenyl)-2,2-dichloroethane]) and 99·6 by 5 per cent. malathion on beef cattle, and 94·5 and 91·8 by 5 per cent. methoxy-DDT (methoxychlor) with and without 10 per cent. butoxypolypropylene glycol on dairy heifers. All the materials were in the form of emulsifiable concentrates diluted in fuel oil. The cables were treated at the beginning of the season with 0·4–0·6 U.S. pint material per ft. and were retreated with 0·15–0·3 U.S. pints whenever they became dry, usually at intervals of 10–14 days according to weather and to the number of animals using the device. The total amount used in the season of eight weeks varied from 2·48 to 3·42 U.S. pints and the amount per animal from 0·06 U.S. pint when there were 60 animals to 0·27 when there were 11. The inclusion of butoxypolypropylene glycol made little difference to the total amount of material needed to treat the devices.

Noland (J. L.). **An improved Method for rearing Cockroaches.**—*J. econ. Ent.* **49** no. 3 pp. 411–412, 1 fig., 3 refs. Menasha, Wis., 1956.

Blattella germanica (L.) was successfully reared for several years in test-tube cages as described in 1949 [*R.A.E.*, B **39** 165], but the water tubes sometimes leaked and a large shelf area in a warm room was needed for storage. The improved design that is illustrated and described in this paper has been used successfully for two years. The main cage units are test tubes similar to those used previously. The watering device is a rubber stopper containing a 15 × 45 mm. vial, which in turn contains a wick made from a dental cotton roll. It is usually necessary to make a single perforation in the wick with a needle to help the flow of water. The cages lie horizontally in racks that are compact to stack and can be kept in a large incubator. For maintenance of an inbred stock colony, pairs of adult cockroaches are fed on a complete proprietary dog food, and the nymphs that hatch from one ootheca (usually about 40) are divided into eight experimental groups, which occupy one rack.

Sferra (P. R.). **A preliminary Investigation of Breakdown of DDT in Granulated Formulations.**—*J. econ. Ent.* **49** no. 3 pp. 414–415, 1 ref. Menasha, Wis., 1956.

Granules of attapulgite, bentonite and tobacco (30–50 mesh), formulated commercially or in the laboratory by solvent impregnation or fusion to

contain 10 per cent. DDT by weight, were analysed for DDT and degradation products. The results showed that the losses of DDT by decomposition immediately after fusion amounted to at least 40 and about 20 per cent. on attapulgite and bentonite, respectively, but there was negligible loss of DDT applied to tobacco by fusion or to tobacco or bentonite by impregnation. A commercial impregnated attapulgite preparation showed some loss, probably due to ageing, when examined after 24–29 months. Fused formulations thus appear to be less stable than solvent-impregnated ones. The heat (100–104°C.) applied during the fusion process evidently intensifies the incompatibility of attapulgite with DDT.

YEOMANS (A. H.). **Tests to develop nonexplosive Mixtures of Solvents in Formulations for Use in Aerosol Generators.**—*J. econ. Ent.* **49** no. 3 pp. 415–416, 2 refs. Menasha, Wis., 1956.

Aerosol formulations containing a mixture of tetrachloroethylene and an inflammable solvent are cheaper than those in which tetrachloroethylene is the only solvent, and experiments have shown that they are equally insecticidal and generally more stable at low temperatures. Experiments were therefore carried out, by a modification of the drum method previously used, to ascertain the proportion of tetrachloroethylene necessary to prevent the aerosol from exploding [*cf. R.A.E.*, B **42** 106–107]. When 73 per cent. tetrachloroethylene was used with 15 per cent. inflammable solvent in mixtures containing 10 per cent. DDT and 2 per cent. γ BHC as lindane, no explosions occurred with nine of the ten solvents tested, and there was an explosion in only one of five replications with the tenth, but all mixtures containing less than 59 per cent. tetrachloroethylene with 27·7–29·3 per cent. inflammable solvent resulted in explosion.

HORSFALL (W. R.). *Aedes sollicitans* **in Illinois.**—*J. econ. Ent.* **49** no. 3 p. 416. Menasha, Wis., 1956.

The following is substantially the author's summary. The distribution of *Aëdes sollicitans* (Wlk.) in Illinois is limited to areas in which solutes in wastes from coal mines, certain factories or oil wells collect in soil subject to transient flooding. The most general feature of its oviposition sites is a sulphurous smell in the soil. The eggs are usually found as a pure population, but sometimes occur at higher levels with *A. stimulans* (Wlk.), *A. vexans* (Mg.), *Psorophora confinnis* (Lynch Arrib.) and *P. ciliata* (F.). The larvae develop in non-saline waters. The form of *A. sollicitans* present in Illinois is apparently the same as that of coastal areas.

FALES (J. H.), BODENSTEIN (O. F.) & BEROZA (M.). **Effectiveness against House Flies of some 3,4-Methylenedioxyphenoxy Compounds as Synergists for Pyrethrins and Allethrin.**—*J. econ. Ent.* **49** no. 3 pp. 419–420, 5 refs. Menasha, Wis., 1956.

Beroza has recently synthesised new compounds of the 3,4-methylenedioxyphenoxy group [*R.A.E.*, B **45** 73], and Gersdorff, Piquett & Beroza have found that some of them show high synergism with both pyrethrins and allethrin when tested against house-flies [*Musca domestica* L.] by the turntable method [**26** 246]. As, however, the Peet-Grady method some-

times gives different results [*cf.* **41** 135] and provides a better indication of synergism as related to knockdown, seven of the compounds that had shown synergism with both insecticides in the turntable tests were examined for synergism with them by the Peet-Grady procedure in comparison with piperonyl butoxide (99·5 per cent.) as a standard synergist. The test solutions contained 0·4 mg. insecticide and 2 mg. synergist per ml. kerosene, and the insecticide alone was tested at 0·4, 0·8 and 1·6 mg. per ml. The percentages of the flies knocked down in five and ten minutes and killed in one day are shown in a table. Pyrethrins in general gave better results than allethrin. The best synergist with both was the 2-(2-ethoxyethoxy)ethyl 3,4-methylenedioxyphenyl acetal of acetaldehyde, which gave 90 and 68 per cent. kill with pyrethrins and allethrin, respectively, as compared with 72 and 56 per cent. when the synergist was piperonyl butoxide and 4 and 14 for the insecticide alone at the lowest concentration. In knockdown, it gave about the same results as piperonyl butoxide. The 2-(2-butoxyethoxy)ethyl 3,4-methylenedioxyphenyl acetal of acetaldehyde was equally good with pyrethrins but much inferior in kill with allethrin. The 2-butoxyethyl 3,4-methylenedioxyphenyl acetal of acetaldehyde and 2-(2-butoxyethoxy)ethyl 3,4-methylenedioxyphenyl ether were slightly more effective than piperonyl butoxide with both insecticides, at least in kill. The other three synergists were 3,4-methylenedioxyphenyl benzenesulphonate, 2-ethoxy-5-(3,4-methylenedioxyphenoxy)tetrahydrofuran and 2-(3,4-methylenedioxyphenoxy)-p-dioxan. They proved clearly inferior to piperonyl butoxide with pyrethrins, but the first two were about equal to it with allethrin. The sprays containing the benzenesulphonate and the dioxane derivative also contained 7·5 and 5 per cent. acetone, respectively, to keep them in solution. An eighth compound shown by Gersdorff to exhibit synergism, 2-(3,4-methylenedioxyphenoxy)tetrahydropyran, was tried in one of the pyrethrins series and was almost ineffective.

Reuter (S.) & Ascher (K. R. S.). **The Action of Di-(*p*-chlorophenyl)-trichloromethylcarbinol (DTMC) and Di-(*p*-chlorophenyl)trifluoromethyl-carbinol on Houseflies.**—*Experientia* **12** no. 8 pp. 316–318, 17 refs. Basle, 1956. (With a Summary in French.)

Although it has been reported that di(p-chlorophenyl)-trifluoromethyl-carbinol [DTFMC] is an excellent synergist for DDT when tested by topical application to DDT-resistant strains of *Musca domestica vicina* Macq. [*R.A.E.*, B **45** 1], adults of a highly resistant strain (R) were practically unaffected by tarsal contact with a deposit, seven days old, of 1 gm. DDT with 1 gm. DTFMC per sq. metre or 0·5 gm. DDT with 0·05, 0·1, 0·25 of 0·5 gm. DTFMC. Similarly, no synergism of DTFMC with DDT against a slightly resistant strain (T) was evident during continuous contact. Alone, it had a slight action that was probably due to fumigant properties, as these were demonstrated when the flies were put on mosquito netting stretched between two halves of a petri dish, the lower half of which bore the deposit. The fumigant effect was apparently suppressed by the addition of DDT to the deposit.

The contact toxicity to R flies of di(p-chlorophenyl)-trichloromethyl-carbinol (DTMC) was short-lived but was greatly prolonged by DDT, 1,1-di(p-chlorophenyl)-2,2-dichloroethylene (DDE), methyl-DDT or 1,1-diphenyl-2,2,2-trichloroethane. This was probably due not to synergistic action but to " support " effect by DDT or the related compound on DTMC. Moreover, contact of R flies for one hour with deposits seven days old of 1 gm. DTMC with 1 gm. DDT and 1 gm. DTMC with 1 gm. DDE per sq.

metre gave 52 and 100 per cent. knockdown, respectively, in 24 hours, whereas there was no knockdown when contact was with 1 gm. DTMC alone or followed or preceded by contact with 1 gm. DDT or DDE. DTMC was more active than DTFMC against T flies, but it had no apparent synergistic effect on DDT against this strain, and did not show any fumigant properties. A closely related compound, di(p-chlorophenyl)-dichloromethyl-carbinol was completely inactive against R flies on continuous contact. Symptoms of poisoning by DTMC in R flies somewhat resembled those described for Pyrolan [**41** 69], but its insecticidal properties were too low to be of practical interest. Excellent acaricidal properties, however, have been claimed for α-trichloromethyl 4,4′-dichlorobenzhydrol [A **44** 171], which seems to be the same compound, though its mode of preparation and physical properties have not been described.

Gear (J.) & others. **Rift Valley Fever in South Africa. A Study of the 1953 Outbreak in the Orange Free State, with special Reference to the Vectors and possible Reservoir Hosts.**—*S. Afr. med. J.* **29** pp. 514–518, 5 refs. Cape Town, 1955.

The following is largely based on the authors' summary. Rift Valley fever was first recognised in South Africa in 1951, when a severe epizootic occurred among sheep, lambs and cattle in the pan veldt, including the western Orange Free State, the southern and south-western Transvaal and the adjoining districts of the north-western Cape Province. Another epizootic occurred among sheep in the south-western Orange Free State in the autumn of 1953. In both outbreaks, there were several cases of human infection among people who handled the meat or viscera of sheep that had died or were killed when suffering from the disease. Mosquitos were collected where the disease occurred in 1953, and the virus was isolated repeatedly from *Aëdes caballus* (Theo.) and *Culex theileri* Theo., which are the predominant species in the pan veldt. Isolation was by intraperitoneal injection into mice, except in one case in which *A. caballus* infected mice by feeding.

Blood from 100 small mammals (15 species) and 14 birds (six species) collected on the farms was submitted to mouse-protection tests and the livers of most of them were exmained for lesions, but the only evidence of Rift Valley fever in them was a positive protection test with the blood of a single polecat (*Ictonyx*). Attempts to isolate the virus from their ectoparasites and from ectoparasites of domestic animals were unsuccessful.

Papers noticed by Title only.

de Ong (E. R.). **Chemistry and Uses of Pesticides.**—2nd edn., 9¼ × 6 ins., vii + 334 pp., 18 figs., many refs. New York, N.Y., Reinhold Publ. Corp.; London, Chapman & Hall, Ltd., 1956. Price £3 10*s*. [See *R.A.E.*, A **45** 258.]

Peyton (E. L.), Galindo (P.) & Blanton (F. S.). **Pictorial Keys to the Genera of Panama Mosquitoes.**—*Mosq. News* **15** no. 2 pp. 95–100, illus., 13 refs. Albany, N. Y., 1955.

[Simit' (Ch.) & Zhivkovit' (V.).] Simitch (Tsch.) & Zivkovitch (V.). **La faune des phlébotomes de Yougoslavie et leur rôle dans l'épidémiologie de la fièvre à papatasi, du kala-azar et du bouton d'orient.**—*Arch. Inst. Pasteur Algérie* **34** no. 3 pp. 380–387, 1 map, 19 refs. Algiers, 1956.

Until the second world war, the only parts of Yugoslavia from which sandfly fever and kala-azar (visceral leishmaniasis) were known were Dalmatia, Herzegovina, Montenegro and Macedonia, and a single autochthonous case of oriental sore (cutaneous leishmaniasis) had been recorded in Macedonia in 1924. During and after the war, these diseases spread considerably, so that sandfly fever is now endemic in the whole country except an area comprising Slovenia, Croatia and western Bosnia, where no species of *Phlebotomus* has been recorded, kala-azar is endemic everywhere except in this area, Vojvodina and northern Bosnia, and oriental sore is endemic in southern and central Dalmatia and Serbia. The first epidemic of sandfly fever outside Macedonia broke out in southern Serbia in the summer of 1945, and the whole of Serbia, except mountain villages, was involved in the following year. Cases were sporadic in 1947–49, but epidemics occurred in Vojvodina and southern Bosnia during 1950–51. The epidemics were associated with the appearance of enormous numbers of the vector, *P. papatasi* (Scop.). There was no epidemic of kala-azar, but the number of cases in Macedonia began to increase from 1943, and the disease spread to southern Serbia, where the first case was recorded in 1945, and subsequently through Herzegovina to southern Bosnia. The situation began to become stabilised in 1952, after which isolated cases were found, particularly in Serbia. Oriental sore spread independently. The first post-war cases were seen in 1945 in Dalmatia, where more than 170 have since been reported. Several small foci have also appeared in Serbia.

Phlebotomus surveys were made throughout the country in more than 400 towns and villages between 15th May and 15th September in 1946–49. As a result, 27,058 sandflies were examined. Among these, 11,056 were taken in places other than bedrooms and included 4,586 individuals of *P. perfiliewi* Parr. (which was the species that the authors believed in 1947 to be undescribed [*R.A.E.*, B **37** 193]), 2,057 of *P. major* Annan., 1,953 of *P. chinensis* var. *simici* Nitzu., 1,434 of *P. papatasi*, 421 of *P. tobbi* Adl. & Thdr., 305 of *P. minutus* Rond., 150 of *P. perniciosus* Newst., 127 of *P. sergenti* Parr. and 23 of *P. bruchoni* Parr. *P. papatasi*, which is the vector of oriental sore as well as sandfly fever, was the most widespread. It was found in bedrooms in all parts of the country in which sandflies occur, and it was also frequent in animal shelters. The distribution of the species found outside bedrooms is reviewed, and it is concluded that the probable vectors of kala-azar are *P. major*, *P. tobbi* and *P. chinensis* var. *simici* in Macedonia, *P. major*, *P. chinensis* var. *simici* and *P. perfiliewi* in Serbia and Kosmet [Kosovo and Metohija], *P. major* and *P. tobbi* in Herzegovina, Montenegro and southern and central Dalmatia, and *P. major* and *P. perniciosus* in northern Dalmatia and Istria.

Callot (J.). **Étude sur les hybrides des biotypes de** *Culex pipiens* **Linné.**—*Ann. Parasit. hum. comp.* **30** no. 4 pp. 363–373, 6 graphs, 11 refs. Paris, 1955.

The experiments described, which deal chiefly with the effects on larval morphology of crossing various subspecies of *Culex pipiens* L., were made with a laboratory strain of *C. p. molestus* Forsk. (*autogenicus* Roub.)

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originating from a female taken biting man in Strasbourg, a strain of *C. p. fatigans* Wied. from French West Africa and examples of *C. p. pipiens* reared from eggs collected in France. The easiest cross was that between *molestus* females and *fatigans* males. Eight males and nine females were put together on 15th June 1954 in a cage measuring 30 × 30 × 30 cm. Eight batches of eggs were laid autogenously on 20th June and hatched next day. The larvae pupated on 3rd July, and males emerged on 5th and females on 7th July. The larvae were intermediate in character between those of the parent strains but bore rather more resemblance to those of *molestus*. The male hypopygium was also intermediate. The adults were ornithophilous, stenogamous and anautogenous. They produced an F_2 generation after engorging on a fowl. The F_2 larvae and adults resembled those of the F_1 generation. The adults were stenogamous and ornithophilous, but readily engorged on man. An F_3 generation was obtained from them. No female of any of the hybrid generations laid eggs autogenously, but dissection showed evidence of autogenesis in the ovaries of seven of 20 F_2 females and three of 30 F_3 females. One of the F_2 females, which had not paired, contained fully developed eggs. In a few experiments on the reciprocal cross, the females fed repeatedly on man, but, although they were inseminated, only one batch of eggs was obtained, and the larvae that hatched from it resembled those of *molestus* so closely that some experimental error is believed to have occurred.

A few experiments involving males of *pipiens* and females of *fatigans* or F_1 *molestus* × *fatigans* hybrids were made in cages measuring 60 × 60 × 60 cm. No eggs were laid by the *fatigans* females, and those that were dissected had not been inseminated. Five hybrid females caged with 12 *pipiens* males from 13th to 31st July all survived for this period, but only one batch of eggs was obtained from them. It was laid on 19th July, and the larvae that hatched had characters intermediate between those of the parents. The five females were dissected on 31st July; their ovaries did not appear to be developing, but the spermathecae of three of them were full of spermatozoa.

Adam (J. P.). **Quelques anophèles nouveaux pour la faune camerounaise.** —*Ann. Parasit. hum. comp.* **30** no. 4 pp. 389–394, 22 refs. Paris, 1955.

Anopheles cinctus (Newst. & Cart.), *A. wellcomei* Theo. and *A. rageaui* Mattingly & Adam [*R.A.E.*, B **43** 80] were found for the first time in the French Cameroons by the author during surveys made since February 1953, and *A. moucheti* Evans, which was recorded from the Cameroons by Zumpt [**26** 17] but was not found by Vaucel & Campourcy [**33** 1] was taken in considerable numbers. *A. cinctus* was found in the larval stage only and seemed to be confined to the south. Most of the larvae were collected at the edges of a slow-running stream near the frontier of Spanish Guinea, associated with *A. nili* (Theo.). Only one was taken some distance to the north where *A. nili* was common, but the larvae were abundant and accompanied by no other species in a locality in Gabon about 100 miles south of the frontier. Two larvae of *A. wellcomei*, the breeding places of which were not previously known, were taken among *Pistia stratiotes* at the edge of the Nyong river, and females in eight villages between July 1953 and March 1954. No gland infection was found in the 38 dissected for malaria parasites, but one had a gut infection.

Larvae of *A. moucheti* were found in the south-west and larvae and adults in an area within a radius of about 20 miles round Yaoundé. The adults represented 45·6 per cent. of the total Anopheline catch in native huts in

18 villages in this area, and much higher percentages in two (Mbalmayo and Ebogo), in each of which over a thousand were taken. Among 812 dissected, 1·6 per cent. had gland infections. Although highly endophilous, *A. moucheti* does not seem to be of great importance as a malaria vector. The author was informed that there was little malaria at Ebogo, where *A. moucheti* was almost the only Anopheline. The larvae were found in abundance only at the edges of large rivers, particularly among *Pistia*.

All stages of *A. rageaui* were found in a subterranean tunnel. The larvae and pupae live in the film of water on the cemented floor and in the gutter running along it. Adults were also taken in an unoccupied dwelling nearby.

Knipe (F. W.). **Characteristics of Nozzle Tips used on Mosquito-control Equipment. A Measurement of Materials lost through Rebound and Atomization.**—*Bull. World Hlth Org.* **13** no. 2 pp. 337–344. Geneva, 1955. (With a Summary in French.)

The following is virtually the author's synopsis. The experiments described were designed to provide information on loss due to rebound and to atomisation of liquid sprayed from two types of nozzle tips on surfaces having various absorptive properties. The two tips discharged almost identical amounts of liquid over the same period of time, but at different pressures. The results indicate a considerable range in rates of absorption by different surfaces. Losses due to rebound and to atomisation appear to be almost identical and total loss identical for each type of nozzle tip at its respective discharge pressure, when each is discharging the same amount of liquid in the same period of time on the same type of surface.

Teesdale (C.). **The Genus *Musa* Linn. and its Rôle in the Breeding of *Aëdes* (*Stegomyia*) *simpsoni* (Theo.) on the Kenya Coast.**—*Bull. ent. Res.* **48** pt. 2 pp. 251–260, 1 graph, 4 refs. London, 1957.

While yellow-fever control work was in progress in ports along the Kenya coast between 1939 and 1952, banana plants continued to be an important source of *Aëdes simpsoni* (Theo.) and *A. aegypti* (L.) [*R.A.E.*, B **30** 123]. As the plants were too valuable to destroy and too numerous and widely distributed to be dusted with an insecticide, the possible existence of varieties unsuitable for breeding was investigated. Seven varieties of banana (*Musa sapientum*) and one of plantain (*M. paradisiaca*) were seen between 1946 and 1950, and their characteristics are described. Routine observations were made on them at Kwale, at an altitude of 1,200 ft., from June 1950 to October 1951 and at Ganda, almost at sea level, from November 1951 to January 1952. The findings are summarised in tables. All the varieties provided breeding sites for *A. simpsoni*, the only species present in appreciable numbers, but some were more suitable than others. It is concluded that no purpose would be served by restricting cultivation to the less favoured varieties, as the ovipositing females would probably make more use of them in the absence of the others. No definite relationship was apparent between the numbers of water-bearing axils or their water contents and the numbers of larvae present. There was more water per axil in the lower and upper axils (those making angles of 90° and over and less than 45° with the stem, respectively) than in the middle ones at Kwale, but the percentage of axils with larvae was generally highest in the middle zone in all varieties. Larvae were found in old axils at the base of the stems, although these axils usually did not appear to provide direct access for the females. It is doubtful whether adults could emerge from them.

In most varieties, water was present throughout the year in the upper

axils only. Except in the period of drought from January to March, when practically no infested foci were found, neither the maximum nor minimum rainfall corresponded with the maximum or minimum number of foci. No breeding was found in April in spite of heavy rain, probably because gravid females were scarce after the preceding dry period and many eggs laid before the rain were washed out of the axils. By May, an increase in the adult population was being reflected in the number of foci found. The rainfall thereafter was adequate to maintain breeding until September to the extent necessary to provide enough gravid females in October to keep larval production fairly high, even when high rainfall must have washed many eggs away. Records from individual axils showed that there was nearly always a loss of water during the day in dry periods and it was often apparently complete, but the water had sometimes been replenished by the following morning even though there had been no rain. Larvae survived in axils that were apparently dry for days at a time. As examination by pipette often fails to reveal the presence of larvae if the amount of water present is very small, assessment of the number of larvae per water-bearing axil is virtually impossible.

Phipps (J.). **Observations on the Behaviour of Culicine Mosquitos in African Huts.**—*Bull. ent. Res.* **48** pt. 2 pp. 275–288, 18 refs. London, 1957.

The following is the author's summary. Observations on the behaviour of *Culex pipiens fatigans* Wied. were made in 24 huts built and occupied by Africans on a sisal estate near Tanga, Tanganyika Territory. Catches were made in four huts each day, an exit trap being fixed on the window from 2 p.m. to 6 p.m. (evening trap) and replaced by another from 6 p.m. to 8 a.m. next day (morning trap), when a spray catch was made of the mosquitos still in the hut. Each hut was used only once a week, for 31 weeks, from December 1952 to July 1953. The females caught were sorted according to the stage in the gonotrophic cycle, as judged by external examination. The stages used were: I, no blood, no visible ovaries; II, stomach full of blood, ovaries small; V, little or no blood, ovaries fully developed; III and IV, intermediate between II and V.

An analysis of variance was performed on the results. Catches of both sexes showed a significant variation with time, which was not, however, correlated with rainfall. Significantly different numbers were taken in the traps and in the huts. Females were significantly most numerous in the hut catch, and males in the morning trap, the former result suggesting that most females spend more than one day in a hut. There were significant differences between the numbers of females in the different stages of the gonotrophic cycle, stages I and II together accounting for 80 per cent. of all females caught. The high proportion of stage I is attributed to delay between emergence and feeding, and of stage II to the taking of more than one meal during the gonotrophic cycle, later meals obscuring the state of ovarian development. There were significant differences between huts as regards the numbers of females caught, but not as regards males, and it is concluded that this is due to variations in the attractiveness of the inhabitants of the huts.

Females in stage I were most numerous in the morning trap, those in stages II–IV were taken only rarely in traps, but there was no significant difference between numbers of stage V caught in huts and in the two window traps. These results are attributed to restlessness in both hungry and gravid females, and sluggishness in fed ones. All stages except III were significantly more numerous in some weeks than in others and this might be due

to variations in either rate of reproduction, or rate of loss of mosquitos from huts. There were significant variations in behaviour in different weeks. For females, this is attributed to changes in the proportions of the stages with time and the dependence of behaviour on stage. For males, there is some evidence of a relation between behaviour and humidity outside the hut. For females, the distribution of stages between different places of capture changes with time, stages II and III being most consistently associated with hut catches, while the most variable behaviour is shown by stage V.

The necessity for behaviour studies on mosquitos in the field is pointed out, especially in relation to field trials of residual insecticides.

NASH (T. A. M.) & STEINER (J. O.). **The Effect of obstructive Clearing on *Glossina palpalis* (R.-D.).**—*Bull. ent. Res.* **48** pt. 2 pp. 323–339, 4 figs., 3 refs. London, 1957.

The following is largely based on the authors' summary. An account is given of two experiments undertaken on the River Kuyi system in northern Nigeria in 1954 and 1955 to ascertain whether felling the trees that form the canopy over a stream and blocking the stream-bed with the trash to obstruct the tsetse's line of flight [*cf. R.A.E.*, B **42** 156–157] would eradicate *Glossina palpalis* (R.-D.). The obstructive clearing was carried out along 2,300 yards of the Kuyi and 1,100 yards of one of its tributaries (the Tawawa) in 1954 and for a total of 2,800 yards along the Upper and Lower Kuyi, from just above the point of their junction, in 1955. In each case, the reaches so cleared were isolated by partial clearing of short streams to their source and barrier clearing of the main stream for 1–1½ miles (straight distance) above and below the experimental blocks. The results obtained in the first year indicated that the conditions created were highly unfavourable for the fly, but eradication was not achieved owing to incomplete isolation. However, although the cleared stream became reinfested in the rains, conditions for at least the first two dry seasons were too unfavourable for the flies to persist. In the second experiment, isolation was satisfactory and eradication was achieved in less than three months.

The immediate effect of obstructive clearing is to increase greatly the hunger of the few surviving flies. Obstructive clearing tends to reduce the number of people visiting the uninhabited parts of a stream owing to destruction of forest produce, and a great reduction in numbers of duiker (*Sylvicapra* and *Cephalophus*) was noticed especially near hamlets. Hunger was therefore probably partly due to reduction in the number of hosts, as well as to the altered environment, which prevents free movement of the hungry fly under shade, and forces it out into the open, where it presumably rapidly succumbs from water-loss.

The mound of trash became overgrown with creepers within a few weeks of obstructive clearing. It tended to sink in the stream-bed during the first heavy rains. The blockage would probably persist for many years on small tributaries but disintegrate within a few years on larger streams and might be displaced in very hilly country, with rapid run-off. In perennial streams of the type used in the experiments, the annual fires made only small inroads into the obstruction. The technique evolved for the clearing is described. Grass along both banks should first be burnt, as the trash is highly inflammable. The actual clearing is carried out in three stages. Small saplings are cut out during the first, the trees of the canopy are felled during the second, and the fallen trash is gathered in the stream-bed during the third. It is important to get as many whole trees as possible into the stream-bed. The labour needed was 390 man-days per mile, about half that needed in the methods now used. Should large-scale undertakings in the field confirm

the effectiveness of the new method, the biggest saving would be the elimination of the need to re-slash partly cleared streams. Observations are to be continued to determine how long it will be before the vegetation again becomes suitable for *G. palpalis*. Notes on the vegetation dealt with in the two years are given in appendices.

Omardeen (T. A.). **The Behaviour of Larvae and Pupae of *Aëdes aegypti* (L.) in Light and Temperature Gradients.**—*Bull. ent. Res.* **48** pt. 2 pp. 349–357, 9 figs., 1 ref. London, 1957.

The following is virtually the author's summary. Experiments with second-, third- and fourth-instar larvae of *Aëdes aegypti* (L.), as well as pupae, were carried out to determine their behaviour in temperature and light gradients in an experimental trough. When second-instar larvae are subjected to a temperature gradient from 42°C. [107·6°F.] to 8°C. [46·4°F.], the majority aggregate over the range of 23–32°C. [73·4–89·6°F.]. Third- and fourth-instar larvae and pupae, however, show a marked preference for the range of 28–32°C. [82·4–89·6°F.]. When subjected to a light gradient from 1·08 to 1·25 log foot-lamberts, second- and third-instar larvae show no marked preference for any one light intensity. The majority of fourth-instar larvae, however, aggregate in the darkest region of the trough, and this negative phototactic reaction is very pronounced in the pupae. This behaviour is probably correlated with the development of sense organs as the larvae grow. In the case of light gradients, it is likely that the increasing negative phototactic reaction is due to the increasing sensitivity of the imaginal compound eye, which starts developing in the early larval instars and reaches an advanced stage in the pupa.

Fryer (J. D.), Johns (D. L.) & Yeo (D.). **The Effects of a chemical Defoliant on an isolated Tsetse Fly Community and its Vegetation.**—*Bull. ent. Res.* **48** pt. 2 pp. 359–373, 1 pl., 1 graph, 12 refs. London, 1957.

The fact that tsetse flies (*Glossina* spp.), which depend on shade for their survival, can be controlled by clearing woody vegetation suggested that they might be economically controlled by herbicides applied from aircraft at a dosage that would defoliate trees without killing them. The results of tests in which 2,4-dichlorophenoxyacetic acid (2,4-D) and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) were applied from aircraft on an island in Lake Victoria in 1950 were not conclusive but indicated that at least temporary defoliation of a wide range of woody species could be obtained. In the following year, K. Holly developed and used a micro-technique for evaluating the defoliant properties of a variety of compounds under tropical conditions and concluded that derivatives of endoxohydrophthalic acid and the chlorinated phenoxyacetic acids were the most promising. He also carried out aircraft spraying trials in Tanganyika, in which the n-butyl esters of 2,4-D and 2,4,5-T were applied in diesel oil at a theoretical rate of 1·05 gals. oil containing 3 lb. compound per acre. Only a small proportion of the spray ejected reached the ground, but the ester of 2,4,5-T defoliated or killed the leaves of many important woody species.

In 1952, the butyl ester of 2,4,5-T was applied on a more extensive scale in Kenya against an isolated population of *Glossina* on the Waturi peninsula (35 acres in area) on the southern shore of the Kavirondo Gulf of Lake Victoria. The main objects were to defoliate the woodland and maintain it leafless for at least three months, to measure the effects on the *Glossina* population, to gain more experience on the effects of applications of 2,4,5-T

from the air on woody species, and to investigate the distribution of the spray droplets in the type of vegetation present. This was dense evergreen thicket around the lake shore and dense mixed evergreen-deciduous thicket in the centre. At the landward end of the peninsula, the thicket gave way to grassland, so that the tsetse habitat was isolated. The main species of *Glossina* present were *G. pallidipes* Aust. in the centre and *G. palpalis* (R.-D.) (subsp. *fuscipes* Newst.) principally near the lake. Catches were carried out weekly on a double octagonal spiral fly-path cut into the thicket, and control catches on a larger but otherwise similar peninsula. The Waturi peninsula was sprayed three times at intervals of about six weeks, starting in April 1952, with the n-butyl ester of 2,4,5-T in solution in a mixture of diesel oil and an aromatic solvent. The amount of spray released per acre was 1·23 gals., but the amounts of 2,4,5-T (acid equivalent) in this quantity were 3·73 lb. for the first application, 1·87 lb. for the second and 1·01 lb. for the third. Assessments of spray deposits from the first application indicated that the percentages of the 2,4,5-T that reached the ground and (in brackets) the volume median diameters of the spray droplets were 49 (176 μ) in the open and 11 (156 μ) inside the canopy.

The following is based on the authors' summary of the results. The first application resulted in defoliation of 13 out of the 15 observed leafy species within 3–4 weeks. Eight of the 13 were dead nine months after the first spraying as were two succulent and leafless species of *Euphorbia*. Of the two leafy species that were not at first seriously affected, one was fully defoliated after the third application and then recovered slowly, but the other, *Lecaniodiscus vaughaniae*, which was a locally dominant species, was only slightly affected at any time.

No significant reduction in the numbers of *Glossina* was observed during 1952. This was probably due to the varying rate of defoliation of the different species, the resistance to the spray of one locally abundant species, the persistent shade cast by the stems of the thick vegetation after defoliation, and the relatively humid atmosphere during the period of maximum defoliation. These factors together probably allowed an environment favourable for the fly to exist in one part or another of the peninsula in spite of the severe effect on the vegetation.

In January 1953 (dry season), between a third and a half of the vegetation was destroyed by an accidental fire. The effect on *G. pallidipes* was almost immediate; the population had been reduced to a fairly low level two months later and remained at about this level for the last 16 months of the experiment. During this period, apparent densities in the control area were 3–12 times as high whereas they had usually been similar before. The main effect of defoliation on *G. palpalis* was to cause it to concentrate near the shady lake shore, where the dominant tree was *L. vaughaniae*. The fire hardly affected this lakeshore habitat. There is little doubt that the destruction of the vegetation by fire was made possible by the effects of the spray applications, as the previously evergreen thicket would normally not have burnt. While this suggests a possible new technique for bush clearance, further trials have indicated several factors that may make difficult a satisfactory burn following defoliation.

DAVIES (L.). **A Study of the Blackfly, *Simulium ornatum* Mg. (Diptera), with particular Reference to its Activity on grazing Cattle.**—*Bull. ent. Res.* **48** pt. 2 pp. 407–424, 4 graphs, 12 refs. London, 1957.

Investigations to provide quantitative information on the activity of *Simulium ornatum* Mg. on cattle under various weather conditions and at different times of day were carried out during 1952–54 in a lowland area

near Durham, in northern England. The aquatic stages occurred in great density in a small stream running beside the pastures, and observations on seasonal changes in their numbers and on oviposition activity were made in 1952 only. As over 99 per cent. of pupae examined were *S. ornatum*, it was assumed that samples taken regularly for counting consisted of this species only. Samples were taken weekly or fortnightly from small stones typical of the substratum of the rapid parts of the stream. They indicated that adults emerge in quantity from April to October. Catches of gravid females on adhesive traps showed that oviposition took place from May to October. It was confined to the period between sunset and dusk. In 1952, females that emerged in early summer were smaller than those that emerged in spring or late summer.

Adults alighted on cows from dawn to dusk. There was usually a small peak in numbers alighting 2–4 hours after dawn. There was a large peak between sunset and dusk on warm, sunny days, but the numbers on cool, cloudy days fluctuated irregularly. Numbers alighting increased greatly if the cow stood near a hedge or other shelter. Landing activity showed no consistent relationship with air temperature or saturation deficit but was markedly decreased or completely inhibited by winds of over five miles an hour. Nearly all adults alighted on the under surface, and about 70 per cent. spent less than ten minutes on the cow. It was calculated that some 8–25 per cent. of the flies that landed bit the cow. The proportion varied significantly from day to day. The number of bites sustained by cattle in the district appeared to cause no ill effect, apart from the formation of scar tissue in the navel region where most bites were inflicted.

Kettle (D. S.) & Parish (R. H.). **Field Trials of Larvicides against *Culicoides* with a Discussion on the Relationship between Rainfall and larval Control.**—*Bull. ent. Res.* **48** pt. 2 pp. 425–434, 1 fig., 6 refs. London, 1957.

The following is largely based on the authors' summary. Further observations were made on Soutra Hill, near Edinburgh, in 1955 on the effectiveness against larvae of *Culicoides impunctatus* Goetgh. of the insecticidal applications that had shown marked delayed activity in 1954 [*R.A.E.*, B **44** 198]. An overall reduction of 76 per cent. in larval populations in untreated plots caused by the long, hot, dry summer complicated analysis of the data, but it appeared that 50 and 200 mg. p,p′DDT per sq. ft. applied as a dust, wettable powder or water-miscible concentrate, 50 and 200 mg. γ BHC per sq. ft. as a wettable powder or 200 mg. as a water-miscible concentrate, dieldrin at 25 mg. per sq. ft. and chlordane at 50 mg. were all still active two years after application. The percentages of control given by the four compounds were 99, 95, 97 and 84, respectively.

The influence of spray volume on insecticidal effect was investigated in 1955 by the application of 25 and 50 mg. p,p′DDT per sq. ft. in 5, 10, 15, 25, 50 and 80 gals. spray per acre. The results were again affected by the exceptional weather. The effect of 50 mg. per sq. ft. at each volume was less marked than in the previous work, when only one concentration was used. There were indications that spray volumes of the order of 15 or 25 gals. per acre give the best results when 50 mg. insecticide is used per sq. ft. The combined results for 50 mg. at all volumes showed only 43 per cent. delayed control, while those for 25 mg. showed none.

The results are discussed with reference to the effect of rainfall on delayed control. It is concluded that the volume of spray applied is unimportant provided that the droplets are closely and evenly distributed on the mossy vegetation that overlies the peat. Subsequent prolonged rain, of the order

of 20 inches, is needed to distribute the insecticide effectively to the surface of the peat, where the eggs are laid and the newly hatched larvae will come in contact with it.

Wirth (W. W.). **Report on a Collection of Biting Midges of the Genus *Culicoides* from Guatemala (Diptera, Heleidae).**—*Proc. ent. Soc. Wash.* **57** no. 3 pp. 109–117, 7 figs., 4 refs. Washington, D.C., 1955.

Records are given of species of *Culicoides* caught on man or horse and at light in two municipalities in the Department of Chimaltenango, Guatemala, at altitudes between 2,700 and 6,300 ft., with notes on the characters of some of them. They were collected by Gibson & Ascoli, who published a paper on four of the species that attack man [*R.A.E.*, B **41** 85–86]. The author states, however, that the one that they recorded as *C. guttatus* (Coq.), though identified as such by himself, was in fact *C. diabolicus* Hoffman, which was described from Panama [and has been considered a synonym of it by Macfie (**39** 93) and Lane (**41** 32)], as he has since satisfied himself that the true *guttatus* is restricted to southern Brazil [**33** 147]. *C. diabolicus* is not among the species for which he gives characters.

Sollers (H.). *Ixodes dentatus* (Marx) **collected from Man (Acarina, Ixodidae).**—*Proc. ent. Soc. Wash.* **57** no. 3 p. 120. Washington, D.C., 1955.

In May 1954, a slightly engorged nymph of *Ixodes dentatus* Marx was found attached to the neck of a child who lived in Washington, D.C., beside a park in which rabbits and birds are numerous. This tick, which is abundant along the Atlantic Coast of the United States, attacks cottontail rabbits [*Sylvilagus*] and, occasionally, other mammals and birds [*cf. R.A.E.*, B **37** 51], but has not hitherto been recorded from man.

Brown (J. H.). **Colorado Tick Fever in Alberta.**—*Canad. J. Zool.* **33** no. 6 pp. 389–390, 3 refs. Ottawa, 1955.

The virus of Colorado tick fever, not previously recorded from Alberta, was isolated from three batches of unfed individuals of *Dermacentor andersoni* Stiles collected there in 1953 and 1954. These batches comprised 250 and 100 ticks from the mountains west of Calgary and 30 from pasture land at Brooks, about 165 miles to the east. The virus thus seems to be widespread in *D. andersoni* in Alberta, but no case of Colorado tick fever in man has been recognised there.

Gelfand (H. M.). *Anopheles gambiae* **Giles and** *Anopheles melas* **Theobald in a coastal Area of Liberia, West Africa.**—*Trans. R. Soc. trop. Med. Hyg.* **49** no. 6 pp. 508–527, 4 figs., 27 refs. London, 1955.

The bionomics of *Anopheles gambiae* Giles and *A. g. melas* Theo., which the author considers distinct species, confirming that the eggs and larvae, but not the adults, can be differentiated by direct examination [*cf. R.A.E.*, B **33** 32], were studied in Marshall Territory, a rural, coastal district of Liberia, from January 1952 to the end of July 1953. The area and its climate are described. Members of the *gambiae-melas* complex comprised

11,331 of 13,404 anthropophilous, night-feeding mosquitos collected in the area, where they are the main vectors of malaria and *Wuchereria bancrofti*. Of 369 females of *gambiae* and 427 of *melas* dissected for malaria parasites, 5·7 and 1·4 per cent., respectively, had sporozoite infections, and of 262 of *gambiae* and 306 of *melas*, 19·5 and 27·1 per cent. had filarial larvae resembling *W. bancrofti* and 1·5 and 3·6 per cent. had mature proboscis infections. As Robertson found *gambiae* and *melas* to be about equally susceptible to malaria infection [**35** 4] and the author found no significant difference in their laboratory susceptibility to infection with *W. bancrofti* [*cf.* **44** 160], it seems that the apparent differences in their natural rates of infection must be explained on the basis of bionomics rather than physiology.

Seasonal periodicity, measured by night-biting catches by a team of two men, was marked, *melas* being most abundant in the late dry season and early rains (January–June) and *gambiae* during the rains (June–November). The seasonal incidence of *melas* is a local characteristic [*cf.* **33** 34] and probably varies from place to place in Liberia. Collections of both mosquitos at increasing distances from the Du River (which is brackish) in April–June 1952 and January–May 1953, showed that the proportion of *melas* declined from 77·1 per cent. at the river's edge to 2·5 per cent. two miles away, and it was not represented in a collection made about 2½ miles from the river. It was not common beyond 3–4 miles from the mouth of the river, though it occurred in small numbers at least ten miles upstream.

Both mosquitos fed readily outdoors if a host was available, but also entered dwellings and penetrated to the upper floors in search of a blood-meal, and both fed at all hours of the night, from dusk to dawn. When a choice of man, goat, pig, fowl, monkey or dog was offered, 207 Anopheline females were attracted to man and only 12 to the other hosts. Of the 65 identified by eggs, 64 were *melas* and one *gambiae*, so that the observation was valid only for *melas*. Studies with window exit-traps showed that almost 90 per cent. of females of *melas* that fed in a hut during the night and 40 per cent. of those of *gambiae* left at or before dawn to seek outdoor shelter. Of those remaining at dawn, 90–95 per cent. of *melas* and 85 per cent. of *gambiae* left at dusk on the same day. Few females of either spent the whole gonotrophic cycle indoors. Efforts to locate their outdoor resting places in Marshall Territory were unsuccessful, but freshly-fed and gravid females of *melas* were abundant on the buttressed trunks of kapok trees and in old termite hills in Monrovia.

The larvae of *melas* never occurred in the swamps of red mangrove (*Rhizophora racemosa*) where tidal influence was felt twice daily throughout the month, but developed mainly in the zone of salt-marsh grass (*Paspalum vaginatum*), which is flooded only by the bi-monthly spring tides in the dry season. Routine collections showed a marked correlation between adult populations and tidal fluctuations. A population peak occurred about 11 days after each spring tide in the dry season, and the effect of the tides became even stronger at the onset of the rains, which caused the areas flooded by the tides to remain submerged for longer. At the height of the rainy season, river level rose and became independent of tides, and the population of *melas* declined. The larvae were found only in brackish water in Marshall Territory, though they were occasionally found in salt-free rain-water puddles in Monrovia. Larvae of *gambiae* were found exclusively in fresh water, generally in small, open, sunlit pools, and breeding was almost restricted to the rainy season. A comparison of the three techniques used for collecting adults (night collections outside inhabited huts by two-man teams of collectors acting as bait, human-baited hut traps and morning collections in huts) showed that the results obtained were strikingly similar, and the three procedures were all valid sampling methods for following the seasonal variations in incidence of the *gambiae-melas* complex.

Elliott (R.). **Larvicidal Control of peridomestic Mosquitoes.**—*Trans. R. Soc. trop. Med. Hyg.* **49** no. 6 pp. 528–542, 4 graphs, 6 refs. London, 1955.

In Eastern Nigeria, there are few natural breeding places for mosquitos in the dry season, and nearly all breeding, even of *Anopheles gambiae* Giles, takes place in the pots that are kept round houses in very large numbers for storing water. An attempt made in 1952 to control infestation by fitting lids to the pots and sealing them down with mud was successful for a time, but local social custom later resulted in a strong resistance to the sealing of the pots. The possibility of using insecticides in the form of pellets consisting of wettable powders stabilised in concrete or plaster of Paris was then investigated. In tests of wettable-powder suspensions to determine the most suitable toxicant to use in the pellets, the concentrations of insecticide, in parts per ten thousand million, required for 50 per cent. kill of fourth-instar larvae of *Aëdes aegypti* (L.) and (in brackets) *Culex pipiens fatigans* Wied. in 24 hours were 35 (9) for dieldrin, 270 (700) for DDT, 1,600 (1,600) for BHC containing 13 per cent. γ isomer and 135 (135) for γ BHC (lindane). The results of these tests and of others in which the insecticides were applied as solutions in alcohol or water are given in some detail; they indicated that DDT, unlike the others, was not sufficiently soluble in water to give 100 per cent. kill in the absence of suspended particles. BHC in any form appeared to owe its toxicity entirely to the γ isomer, and the presence of the other isomers, which are toxic to vertebrates, would increase the hazard of drinking treated water without corresponding insecticidal advantage. Dieldrin, although 25 times more toxic to vertebrates than γ BHC, is about 60 times less soluble and might therefore be safer. Limited tests with larvae of *Anopheles gambiae* showed that they were much more sensitive to the insecticides than those of the other two species.

Various types of insecticidal briquettes and pellets were tested in field trials for the control of *Aëdes aegypti* in the storage pots. Pellets stabilised with plaster of Paris containing up to one part wettable powder to three parts plaster were effective until they disintegrated, which they did after periods that varied according to circumstances. Because of the mechanical instability of the plaster briquettes and the white sediment deposited, they were abandoned in favour of sand and cement pellets. These were not effective for long when DDT was the toxicant, but small pellets (10 gm.) gave complete control of *A. aegypti* for at least a year when either dieldrin or lindane was used at 16 per cent. by weight. The best proportion of sand to cement was found to be 5:1. The possibility of using pellets to control larvae in larger breeding places such as borrow pits is briefly considered.

Cherry (J. K. T.). **The Prevention and Treatment of Tick-Borne Relapsing Fever with special Reference to Aureomycin and Terramycin. I. The Control of Tick-borne Relapsing Fever in Ankole.**—*Trans. R. Soc. trop. Med. Hyg.* **49** no. 6 pp. 563–568, 1 graph, 7 refs. London, 1955. **II. The Treatment of Tick-borne Relapsing Fever with special Reference to Aureomycin and Terramycin.**—*T. c.* pp. 569–573, 18 refs.

In the first part of this paper, an account is given of an experiment begun in 1951 on the control of *Ornithodoros moubata* (Murr.) in African dwellings in the Ankole district of Uganda with BHC [*cf. R.A.E.*, B **42** 17, etc.] applied as a spray. *O. moubata* is the vector of relapsing fever in Uganda, and Ankole is the main focus. In the pilot scheme around Mbarara, the chief centre of infection, the 1,181 houses were treated by spraying the floors

and walls to a height of three feet with 0·5 gal. per 1,000 sq. ft. of a mixture of 12 oz. P.520 per gal. water to give a deposit of 11 gm. γ BHC per sq. ft. P.520 is a water-dispersible powder containing technical BHC and is relatively cheap and odourless. The houses were resprayed after 3–10 months. All the houses were examined for ticks before the first treatment, and 904 and 359 were examined 3 and 9 months later (before retreatment). The only ones in which ticks were found were 66 at the first examination, 13 of these 66 at the second, and 3 of the 13 at the third. At least 35 cases of relapsing fever originated in the treated houses in the year before treatment and none occurred in them in the year after it. The campaign was extended to other foci in 1952, and 8,431 houses had been treated by 31st July 1953. No relapsing fever occurred in any of these houses between treatment and the end of 1953. The numbers of cases recorded annually in Ankole were 327–393 in 1947–50, 192 in 1951, 47 in 1952 and 32 in 1953. There was no evidence of a corresponding decline in adjoining districts. The fall was apparently due to the organised spraying, together with the use of BHC by individual householders impressed by the success of the campaign.

Jackson (C. H. N.). **The natural Reservoir of** *Trypanosoma rhodesiense*. —*Trans. R. Soc. trop. Med. Hyg.* **49** no. 6 pp. 582–587, 3 maps, 3 refs. London, 1955.

It was reported by H. Fairbairn in 1948 that cases of sleeping sickness caused by *Trypanosoma rhodesiense* usually occur each year on the Ugala river in the Tabora district of Tanganyika among fishermen who go there in the dry season, despite the absence of man for six months in the rains. *Glossina morsitans* Westw. is the only tsetse in the area, there are many kinds of antelope and other game animals, a list of which is given, and baboons are common. Records are given of 20 cases of infection with *T. rhodesiense* that, together with three others, are known to have occurred in 1938–39 among Africans employed during experiments in an area around Kakoma closed to settlement on account of sleeping sickness and bounded at one end by the Ugala. Nearly half of them occurred in camps some miles from any permitted route, although comparatively few people were stationed there. One case had also occurred at Kakoma in each of the years 1935 and 1936 and one has occurred since in another closed area in Tanganyika. There was also one in 1943 at Lugala in Uganda, a district closed to settlement because of sleeping sickness, and a strain of *T. rhodesiense* was obtained there from *G. pallidipes* Aust. [*R.A.E.*, B **33** 101]. As man is not a preferred host of *G. pallidipes*, and there were very few people at Lugala, the author considers it unlikely that the fly from which the strain was recovered and the one that bit the man who developed the disease, had acquired the infection from man. He concludes that the evidence from these areas, unlike that obtained by Dye, who worked in south-eastern Tanganyika [**16** 90], indicates that wild animals must form a reservoir of the disease in nature, as they have been shown to do experimentally in capitivity.

Dowling (M. A. C.). **An Experiment in Mosquito Control using Dieldrin dispersed as a dry Fog.**—*Trans. R. Soc. trop. Med. Hyg.* **49** no. 6 pp. 590–598, 5 figs., 3 refs. London, 1955. **Addendum.**—*T. c.* pp. 598–601, 1 fig., 1 ref.

In view of the increasing risk of the introduction of yellow fever into Malaya by fast air services, mosquito control around the new international

airport at Paya Lebar, Singapore, is of prime importance. The potential local vectors include *Aëdes aegypti* (L.), which has a localised distribution in inhabited areas and *A. albopictus* (Skuse), which is widespread throughout Singapore and particularly abundant near the airport. *A. aegypti* can be satisfactorily controlled by house-treatment with insecticide deposits and by larval control enforced by legislation, but *A. albopictus* is not affected by house-treatment, as it rests out of doors, and cannot be controlled in the larval stage, as it breeds in tree-holes. An account is given of a pilot experiment made on an island 4½ sq. miles in area on the control of adults of *A. albopictus* and other mosquitos in jungle and open country and in houses with dieldrin dispersed as a dry fog from a Swingfog generator [*cf. R.A.E.*, B **44** 130] through a 0·9 mm. flow control jet. The preparation used was undiluted Dieldrex 15, an emulsion concentrate containing 15 per cent. dieldrin, and the rate of outdoor application was 0·8 oz. dieldrin per acre. The whole island was treated in 85 man-hours during the week beginning 28th February 1955, all outdoor work being done early in the morning while inversion conditions prevailed. Dispersal was not affected by heavy rainfall. Houses were treated by fogging every room and were kept closed for five minutes after treatment. Established methods of control were continued during the pre-treatment period, but discontinued after fogging began.

There was a very considerable reduction in the numbers of mosquitos taken in catching stations after treatment. For the first five weeks, catches of *A. albopictus* were 4·7, 20·8, 48·2, 35·2 and 52·9 per cent., respectively, of the mean catch for two weeks preceding treatment. A high degree of control of the other four prevalent species (*A. butleri* Theo. and three species of *Culex*) was maintained for a month or more. There was little fluctuation in catches of *Culex* spp. in control stations on the mainland of Singapore. The results suggested that weekly treatment, combined with a heavier rate of application on typical breeding areas of *A. albopictus*, might produce a prolonged reduction in numbers of the latter comparable with that effected in populations of other species. Circumstances in which fogging might be a particularly useful method of control are discussed.

Results of further work are the subject of the addendum. Control of *A. albopictus* on another small island was maintained for eight weeks by means of two treatments at an interval of one week. Had the double application been preceded and followed by species sanitation to reduce available breeding places, the mosquito might have been eliminated. The combined methods have been used near the new airport with promising results. Experiments in temporary and base camps in Malaya and elsewhere indicated that fogging had limitations as a single measure, unless the camp was a small clearing in jungle. Fogging with dieldrin gave good control of *Mansonia uniformis* (Theo.), the vector of *Dirofilaria immitis*, which was causing considerable morbidity among military guard-dogs. Control was later prolonged by the use of dieldrin at 2 oz. per acre distributed as pellets in the ponds of water hyacinth [*Eichhornia*] in which *M. uniformis* breeds.

Microchemical analysis of filter papers placed downwind failed to show the way in which the fog dispersed, because the amounts of insecticide were too small. Observations were therefore made in which the carrier was an oil of which the droplets could be counted because they are fluorescent in ultra-violet light. In this way, it was found that there is a heavy deposition of fog on impact in the first ten yards from the source because of the turbulence created directly by the machine. If the operator stands more than ten yards from vegetation, the initial turbulence subsides and the normal drift begins at that distance. There is more deposition by impact in wind than with a simple drift, but the fog penetrates further. The

decrease in amount of deposition with distance conformed to the general laws governing the downwind drift of non-persistent smokes and gases, in that, if the number of droplets on a filter paper were 100 at 10 yards from the machine, it would be 50 at 20 yards, 25 at 40 yards and so on.

The size of the droplets emitted by a Swingfog machine depends not only on the aperture of the flow control jet but also on the type of liquid carrier. Droplets are larger and output is greater with kerosene than with diesel fuel, which therefore causes a given amount of insecticide to spread over a larger area. The average size of the droplets emitted in the control experiments was 5 μ (less than a quarter of the standard size generally used), which allows a long drift downwind. The effective mosquito control obtained by fine dispersion of less than 1 oz. dieldrin per acre was unexpected, but may be explained partly by the high concentration of dieldrin in the droplets and partly by the presence in Dieldrex 15 of an emulsifier that facilitates penetration of the insect cuticle. Experiments with simple solutions or with lower concentrations of dieldrin gave poor results.

Mattingly (P. F.) & Knight (K. L.). **The Mosquitoes of Arabia. I.**— *Bull. Brit. Mus. (nat. Hist.)* Ent. **4** no. 3 pp. 89–141, 4 figs., 2½ pp. refs. London, 1956.

From a revision of existing material and records, 46 species, subspecies and varieties of mosquitos (including 17 of the genus *Anopheles*) are recorded as occurring in the Arabian area (comprising the whole peninsula south of Sinai, Transjordan and Iraq, the immediately adjacent islands and Socotra). They include *Anopheles demeilloni* Evans, *Aëdes caballus* (Theo.), *Culex pipiens* var. *molestus* Forsk., *C. arbiceni* Salem and *C. duttoni* Theo., which are recorded from Arabia for the first time. A small number of species previously recorded (including *Anopheles hyrcanus* (Pall.) and *A. subpictus* Grassi) are believed to have been misidentified. The taxonomic position of a few others is reassessed. It is considered that *A. adenensis* Christ. [*cf. R.A.E.*, B **36** 60], *A. macmahoni* Evans [**25** 106] (the presence of which in Arabia was not confirmed) and *A. rupicolus* Lewis are subspecies of *A. culicifacies* Giles, *A. sergentii* (Theo.) and *A. rhodesiensis* Theo. [*cf.* **44** 196], respectively, that *A. arabicus* Chr. & K. C. is a synonym of *A. fluviatilis* James, and that *A. hispaniola* (Theo.) is not identical with *A. turkhudi* List. [*cf.* **39** 22], but is more closely related to *A. cinereus* Theo. [*cf.* also **45** 66]. *A. turkhudi* and *A. cinereus* occur in Arabia, but *A. hispaniola* is not known to do so.

Aëdes aegypti (L.) occurs in Arabia, as in many other parts of its range, in two distinct forms, the pale type form, originally described from Egypt, and a darker form, jet black over most of Africa south of the Sahara but tending to be somewhat browner elsewhere. The name *A. acgypti* var. *queenslandensis* (Theo.) has been used for the pale form, on the erroneous assumption that the dark one is the type form. They interbreed readily in the laboratory, and almost certainly do so in nature, as every degree of intergradation is found where they come into contact, as in coastal parts of Africa. Both have been introduced into many parts of the world, but they show little tendency to spread beyond the point of introduction. Their distribution is being studied with a view to their being named as subspecies. The pale form is thought to be introduced in Africa south of the Sahara, as it is almost confined to the coast, except for limited penetration inland along a few major lines of communication. It occurs to an unspecified extent in India and is also known from northern Australia, while a very pale island population has been found near Singapore. Both pale forms and intermediates occur in the West Indies and the southern United States. The

pale form is apparently more highly domestic than the dark one, so that their interbreeding may have been a factor of importance in the history of urban yellow fever, and their co-existence in an area, as in Mombasa [**44** 5], raises great problems of control. There is reason to suspect that one of the strains used by Gillett in recent genetical studies [**43** 168; **44** 184] may have been a pale-dark hybrid, and the possible occurrence of hybrids must be taken into consideration in all genetical work on *A. aegypti*.

Keys are given for the identification of adults and fourth-instar larvae of the Arabian mosquitos, and *Anopheles hyrcanus* and *A. subpictus* are included in them as well as *A. superpictus* Grassi, which will most probably be found to occur in northern Arabia, though it has not so far been recorded from there. All available distribution records are given, together with a list of the localities concerned and their approximate altitudes, latitudes and longitudes, and distribution within the Arabian area is discussed. The zoogeography of the fauna is considered, and the conclusion is reached that the latter is mainly Palaearctic with a very small Oriental element, largely confined to the coasts of the Persian Gulf and the Gulf of Oman, and a larger Ethiopian element confined to the south-western corner.

Laven (H.). **X-ray induced Mutations in Mosquitoes.**—*Proc. R. ent. Soc. Lond.* (A) **31** pt. 1–3 pp. 17–19, 1 pl., 7 refs. London, 1956.

To confirm the hypothesis of cytoplasmic inheritance as the explanation of non-reciprocal compatibility between certain strains of *Culex pipiens* L. [*cf. R.A.E.*, B **43** 49, etc.], it was necessary to isolate mutant genes from among the experimental populations. A search for spontaneous mutations was not very successful, but a single treatment of males 2–3 days old with X-rays (4000r) produced several very promising visible aberrations that have proved to be heritable. Using these mutants, it will be possible to mark each of the chromosomes in the *Culex* nucleus with at least one gene and probably with more and lay the foundations of a formal genetics in *Culex* by working out the first linkage groups. Two of the mutations produced appear to mark the autosomal chromosomes because they are independent of sex. A third is clearly sex-linked, and a fourth behaves similarly but is not a good marker because it is coupled with a lethal factor or lethal factors. Brief descriptions and figures are given of four mutations, which together seem to mark all the existing chromosomes in *Culex*, the two autosomes and the sex chromosomes of each sex.

Haufe (W. O.) & Burgess (L.). **Development of *Aedes* (Diptera: Culicidae) at Fort Churchill, Manitoba, and Prediction of Dates of Emergence.**—*Ecology* **37** no. 3 pp. 500–519, 8 figs., 34 refs. Brooklyn, N.Y., 1956.

The following is virtually the authors' summary. Formulae for predicting mosquito emergence are suggested from three years' field observations on the development of species of *Aëdes* at Fort Churchill, Manitoba. The development of post-hatching stages of both males and females of *A. communis* (Deg.) could be described by a common mathematical curve provided that the immature stages were not subjected to temperatures above the optimum for the species. Curves of development were drawn for the pest species at Churchill on the basis of emergences of each species in at least three pools having different thermal characteristics. Lower thresholds of development and products of time and temperature are tabulated for the periods of development of common species.

The tundra species (*A. impiger* (Wlk.) and *A. nigripes* (Zett.)) had lower thresholds of development approximating 34°F.; the forest species (*A.*

communis, *A. punctor* (Kby.), *A. excrucians* (Wlk.)) had a range of 38–40°F., except *A. hexodontus* Dyar, which appeared to have an exceptionally high value of 45°F. The products of time and temperature for the period of development of both tundra and forest species were lower for the smaller than for the larger species. For the Fort Churchill area they were 260 to 440 degree-days for the common species of *Aëdes*. The peak emergence of males of *A. communis* consistently preceded that of the females. Mathematical descriptions were constructed for the relation between meteorological elements (temperature, dry cooling power of the atmosphere, and daily amount of sunshine) and the daily average of temperature of mosquito pools.

McCulloch (R. N.). **DDT-resistance in House Flies. Experience at Roseworthy Agricultural College.**—*J. Dep. Agric. S. Aust.* **59** no. 5 pp. 200–202, 2 figs. Adelaide, 1955.

DDT gave good control of house-flies (*Musca domestica* L.) at Roseworthy Agricultural College, South Australia, in 1947–50, but populations then began to rise again. The piggery was sprayed twice with DDT and twice with BHC in the spring of 1952, but populations were so great two weeks after the last spraying that another method had to be adopted in December. Manure from the piggery, dairy and stables was spread on the ground daily in a layer 2 ins. thick or less, and by this means satisfactory control was maintained throughout the summer, when the sun temperature of the surface soil often exceeds 140°F. Some breeding took place in autumn, however, until the manure was spread at a thickness of 1 inch or less. In autumn and spring, these thin layers dried out soon enough to kill the larvae in the absence of rain, and became too cold at night for them to survive when rain fell. Manure was not spread during winter, when adults were rare and no oviposition was observed. Control was satisfactory until February 1955, when the flies again became a pest in the dairy. There had been heavy rain that presumably allowed larvae to develop in the manure in the paddocks used by pigs and dairy stock, where their development in late summer would normally be prevented by natural drying. Also, the piggery had been removed from a site 50 yards away from the dairy to one 600 yards away, and this may have resulted in oviposition in the dairy and stable yards by females that would formerly have been deflected to the more attractive piggery bedding and manure. Spraying with DDT gave poor control, and males and females bred from 30 adults collected from the sprayed walls of the milk room were found to be 15 and 40 times as resistant, respectively, to DDT as those of a susceptible laboratory strain, on the basis of LD50's.

Papers noticed by Title only.

Pradhan (S.) & Rangarao (P. V.). **Effect of Post-treatment Temperature on Insect Resistance to insecticidal Sprays.**—*Bull. ent. Res.* **48** pt. 2 pp. 261–274, 6 graphs, 28 refs. London, 1957. [See *R.A.E.*, A **45** 313.]

Gerolt (P.). **Method for Breeding, Handling and Sexing Adults of *Drosophila melanogaster* Mg. as a Test Insect for Bioassay.**—*Bull. ent. Res.* **48** pt. 2 pp. 311–315, 1 pl., 1 graph. London, 1957. [See *R.A.E.*, A **45** 315.]

World Health Organization. **Specifications for Pesticides. Insecticides, Rodenticides, Molluscicides, and Spraying and Dusting Apparatus.**—400 pp., 22 figs. Geneva, 1956. Price £2.

This manual, which supersedes a work published in loose-leaf form in 1953 [*R.A.E.*, B **42** 16], contains specifications drawn up by the Expert Committee on Insecticides of the World Health Organisation for insecticides, insecticidal preparations and auxiliary chemicals intended for use against vectors of diseases of man, substances used in the control of rodents and aquatic snails, and spraying and dusting equipment (compression, hand and stirrup-pump sprayers and hand-activated plunger-type and rotary dusters). The insecticides dealt with are technical grades of BHC, DDT, methoxy-DDT (methoxychlor), chlordane, allethrin, Diazinon (essentially O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate), malathion and parathion, pyrethrum extract (aerosol grade), dieldrin, refined BHC (containing 16·1–98·9 per cent. γ isomer) and γ BHC (at least 99 per cent. pure); the preparations are water-dispersible powders and emulsion concentrates containing DDT, BHC, methoxy-DDT, chlordane, dieldrin, Diazinon and malathion, parathion emulsion concentrates and dusting powders of DDT and BHC; and the auxiliary chemicals are 2,4-dinitroanisole and technical chloromethyl p-chlorophenyl sulphone, piperonyl butoxide, sulfoxide (essentially 1,2-methylenedioxy-4-(2-(octylsulphinyl)propyl)benzene), isopropyl cresol and 2,2′-methylene-bis(4-methyl-6-tert.-butylphenol).

Alessandrini (M. E.). **Nouvelle méthode de prélèvement du DDT ou d'autres insecticides sur des surfaces traitées.**—*Bull. World Hlth Org.* **13** no. 6 pp. 999–1002, 3 refs. Geneva, 1955. (With a Summary in English.)

Adhesive tapes have been tried for the collection of DDT from treated surfaces so that the amount present might be determined, but are unsatisfactory because the adhesives contain organic compounds. These are always to some extent dissolved by the solvents used to remove the DDT and affect coloration. An inert agent for recovering superficial DDT from treated surfaces was therefore sought, and a description is given of a method that was found successful. It consists in spreading a very thin layer of a suitable silicone on a strip of parchment paper and pressing the paper hard against the surface from which it is desired to recover the DDT. The DDT is then dissolved in acetone, the solution is evaporated and the amount of DDT present in the residue is determined.

Usova (Z. V.). **Some Results of Tests on the Effect of DDT and Hexachlorane on Blackflies (Fam. Simuliidae) under Laboratory Conditions and in Nature.** [*In Russian.*]—*Dokl. Akad. Nauk SSSR* **109** no. 2 pp. 417–420, 8 refs. Moscow, 1956.

Simuliids are abundant in the Karelo-Finnish Republic, and DDT and three grades of BHC were tested for their control in 1954–55 as solutions in emulsifiable solar oil. Rates of application in the tests against the immature stages are given as parts solution per million parts water. The three grades of BHC were the technical product and products containing 23–28 and 84·6 per cent. γ isomer, and these are referred to below as BHC-1, BHC-2 and BHC-8, respectively.

In laboratory tests, in which eggs or larvae of mixed species were exposed for 10–60 minutes in water containing the solutions at 100 p.p.m., 10–50 per cent. DDT or BHC-2 caused hardly any mortality of eggs, and 40–50

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per cent. BHC-8 permitted 88–95 per cent. of the eggs to hatch, though their hatching was somewhat retarded. In tests of 20 per cent. solutions against the larvae, the minimum periods of exposure in minutes required for 100 per cent. mortality in ten hours or less were 60 for DDT and 10 for all grades of BHC. In general the three grades of BHC acted more rapidly when the solution concentration was increased to 30 per cent., though 20 minutes' exposure was required for 100 per cent. kill in 10 hours with BHC-1; mortality after exposure for 10, 20 and 60 minutes to BHC-8, which was the most rapid in action, was complete in 7–8, 5–6 and 3–4 hours, respectively.

Solutions containing 20 per cent. DDT or BHC-1 were used in field tests. In 1954, a stream about 550 yards long, infested throughout its length by larvae and pupae of *Simulium ornatum* Mg., *S. reptans truncatum* (Lundstr.) and *S.* (*Eusimulium*) *latipes* (Mg.), was treated in late May by applying the DDT solution at the source for 25 minutes to give a concentration of 100 p.p.m. All the larvae became detached in 30–50 minutes, and many were observed floating with the current. All had disappeared after 20 hours, but there was no effect on the pupae, or on the eggs of *Cnephia* (*E.*) *richteri* (End.) or *S.* (*E.*) *bicorne* Dorog., Rubtsov & Vlasenko. Larvae and pupae of the last two were numerous in the stream in 1955, and those of *S. latipes* and *S. reptans truncatum* rare. It was treated in late June 1955 with the BHC solution for 20 minutes to give a concentration of 10 p.p.m. All the larvae disappeared in a day, and the only ones present in August were those of species that were in the egg stage at the time of treatment. A larger stream, about 2,200 yards long, was treated with the BHC solution for 63 minutes to give a concentration of 1 p.p.m. Larvae and pupae of *S. bicorne* and *S. latipes* were present in the upper reaches, where the water temperature was 6–8·5°C. [about 45°F.], and those of *S. reptans truncatum* at its mouth, where it was 13·5°C. [56·3°F.]. The larvae all became detached in a few minutes, and only two of a hundred collected from the water were alive. Larvae remained absent until August, when eggs hatched.

The three grades of BHC were tested against the adults by exposing females of *S. reptans galeratum* Edw. for 3–5 seconds on the hide of a calf that had been lightly smeared with 2 per cent. solutions. The subsequent periods in minutes required for paralysis and (in brackets) death were 30 (60) for BHC-1, 20–30 (90) for BHC-2 and 10–15 (30–40) for BHC-8 if the females were hungry, and 50–60 (120) for BHC-1 and 20–40 (60) for BHC-8 if they had fed. When the solution of BHC-1 was applied to the neck, chest and abdomen of a horse in the field, where the main Simuliid was *S. reptans galeratum*, the treated parts were completely protected for several hours. Two days later, the Simuliids were only about half as numerous round the treated horse as round an untreated one, and those that were collected from the treated parts (on which fair numbers settled but few fed) died in 4–5 hours. After 3–4 days, there was no difference in the attack on the treated and untreated animals.

WINTERINGHAM (F. P. W.). **Labelled Metabolic Pools for studying quantitatively the Biochemistry of toxic Action.**—*Int. J. appl. Radiat. Isotopes* **1** pp. 57–65, 3 figs., 15 refs. London, 1956. (With Summaries in French, Russian & German.)

The following is based on the author's synopsis. A powerful method for studying the biochemistry of acute toxic action *in vivo* would be one in which the whole range of metabolites involved in immediate survival could be determined quantitatively in the tissues of control and of poisoned animals. The possibility of doing this with insects has been demonstrated

by the application of quantitative radiochromatographic techniques [*cf. R.A.E.*, B **44** 185]. Some interesting results have been obtained. For example, exposure of flies (*Musca domestica* L.) to methyl bromide (an SH-enzyme inhibitor) brings about a spectacular depletion of adenosine triphosphate, the entire phosphate sometimes appearing as PO_4^{3-} and not as adenylic acid or adenosine diphosphate, as might be expected. The nature and relative specific activities of the ^{32}P-labelled intermediates extracted from tissues have been determined by co-chromatographic and neutron activation techniques. This work has recently been extended to the use of ^{14}C-labelled pools by the injection of a suitable substrate such as 2-^{14}C acetate. Certain amino acids and acetylcholine, an important substance in vertebrate nerve-muscle function, have been identified and estimated among the labelled intermediates formed in normal house-flies and in house-flies poisoned with diisopropyl phosphorofluoridate. This substance caused a temporary increase in the acetylcholine level, but also interfered with amino-acid metabolism, which resulted in an accumulation of glutamine.

Bettini (S.) & Boccacci (M.). **Azione tossica degli acidi iodo- e cloroacetico sugli insetti. Inibizione della triosofosfato deidrogenasi.** [The toxic Action of Iodo- and Chloroacetic Acids on Insects. The Inhibition of Triosephosphate Dehydrogenase.]—*Riv. Parassit.* **16** no. 1 pp. 13–29, 7 figs., 22 refs. Rome, 1955. (With a Summary in English.)

The authors have shown that iodoacetic and chloroacetic acids act as contact insecticides, apparently by inhibiting triosephosphate dehydrogenase (TPD), and here give an account of the technique and results of studies of their action on this enzyme in which the insects used were *Periplaneta americana* (L.) for *in vivo* and *in vitro* tests of iodoacetic acid and two strains of *Musca domestica* L., one resistant and one susceptible to DDT, chlordane and other chlorinated hydrocarbons, for tests with deposits of chloroacetic acid. TPD activity in the insects was estimated by a colorimetric method, which is described in detail, and was found to be equal in the two species and strains.

Extracts of the coxae of *P. americana* were used for the *in vitro* tests, and the inhibition of TPD was proportional to the length of time for which the extracts were incubated with iodoacetic acid. *In vivo*, the injection of 1 mg. iodoacetic acid per gm. body weight (ten LD50's) into female cockroaches resulted in complete inhibition of TPD in the coxal muscle in an hour. In the tests with *M. domestica*, the flies were exposed for one hour on blotting paper that had been treated with solutions of chloroacetic acid in olive oil. Mortality as well as TPD inhibition was investigated and was estimated from the percentages of flies knocked down in 24 hours, as there is no recovery from knockdown. The deposits in gm. per sq. m. required for 50 per cent. knockdown of females and (in brackets) males in three series of tests were 0·65–1·5 (0·37–0·65) for the strain susceptible to chlorinated hydrocarbons and 0·8–1·7 (0·4–0·8) for the strain resistant to them. The curve obtained for TPD inhibition in the latter strain is given and is parallel to, but lower than, the curve for mortality.

Attempts to obtain strains of *M. domestica* resistant to chloroacetic acid were made by exposing adults of successive generations to deposits sufficient to give 60 per cent. mortality, and breeding from the survivors. The strain resistant to chlorinated hydrocarbons was reared for 30 generations in this way and the other strain for 27, but there was no noticeable increase in tolerance of chloroacetic acid in the flies obtained and no variation in the TPD activity of extracts prepared from them. It is concluded that the mechanism of toxicity of the chlorinated hydrocarbons differs from that of

the halogenated alkylating substances, and resistance to the former group does not extend to the chlorine-containing compounds of the latter.

HAWKINS (W. B.). **The joint Action of DDT and Ethyl Alcohol upon Anopheline Larvae in Bioassay Suspensions.**—*J. econ. Ent.* **49** no. 4 pp. 433–435, 2 figs., 2 refs. Menasha, Wis., 1956.

It has previously been found that several factors affect the evaluation against Anopheline larvae of colloidal suspensions of DDT produced by dispersing ethanol solutions in water [*R.A.E.*, B **41** 41; **44** 131], and the experiments described in this paper show that an additional one is the amount of ethanol used to produce the suspension. The test insects were early fourth-instar larvae of *Anopheles quadrimaculatus* Say in Pyrex glass dishes, and mortality counts were made after 24 hours. In tests in which the concentrations of DDT in the solutions were such that the required doses were obtained in suspensions containing 1, 0·1 or 0·01 per cent. ethanol by volume, the LD50 of the DDT doubled with each ten-fold decrease in the concentration of the alcohol. The LD90 showed no increase when the percentage of alcohol decreased from 1 to 0·1, but doubled when the alcohol content was further lowered to 0·01 per cent. In tests in which initial suspensions containing 5 or 500 μg. DDT and 1 ml. ethanol in 100 ml. water were further diluted so that the concentrations of DDT and ethanol decreased in the same proportion, the kill of larvae again decreased with each lowering of the alcohol concentration, but the decrease was greater than would be expected from the tests in which the constant concentrations were compared, indicating the influence of other, but unknown factors. The toxic action of DDT was increased by conditioning the larvae in 2 per cent. alcohol solution for four hours and transferring them to distilled water for 15 minutes before putting them in DDT suspensions containing small amounts of alcohol. It is not known whether the alcohol affects the cuticle so that the DDT can penetrate more rapidly or affects some internal physiological system so that the DDT is more toxic.

FURMAN (D. P.) & WEINMANN (C. J.). **Toxicity of Malathion to Poultry and their Ectoparasites.**—*J. econ. Ent.* **49** no. 4 pp. 447–450, 7 refs. Menasha, Wis., 1956.

The effect of malathion on poultry was examined in California by dipping hens nine months old and turkeys 12–15 weeks old in emulsions of various concentrations for about 20 seconds without submerging the head. All the birds (five hens and four turkeys) dipped in 1 per cent. malathion survived the treatment, but three of the fowls showed temporary abnormal symptoms. A 2 per cent. dip, which was tested on four turkeys only, killed one and caused temporary abnormality in two. All birds treated in 4 per cent. dips (five hens, four turkeys and one mature goose) were killed. Autopsy of turkeys that died or became moribund after immersion in malathion dips showed little gross pathology.

The effectiveness of the emulsion on certain ectoparasites of fowls was also examined. A 1 per cent. roost spray controlled *Menacanthus stramineus* (Nitzsch) on a ranch in which the fowls were in close proximity with treated surfaces for 24 hours a day but not on one in which proximity to treated surfaces was limited to the hours of darkness. A 3 per cent. spray gave effective control on both ranches. The effectiveness of the spray deposits, as determined by artificial reinfestation, was largely dissipated within 3–5 weeks. Laboratory and field tests indicated that exposure to a surface sprayed with a 3 per cent. emulsion was lethal to *Argas persicus*

(Oken) only if the ticks remained on it for periods ranging from 9 hours immediately after treatment to 34 hours 2–4 weeks later. In comparative field tests, 3 per cent. malathion applied at 5·3–13·8 mg. per sq. ft. was less effective in controlling the ticks than an emulsion spray containing 2 per cent. aldrin applied at 6·1 ml. per sq. ft. [*cf. R.A.E.*, B **42** 142]. One of the houses sprayed with 3 per cent. malathion was heavily infested with *Dermanyssus gallinae* (Deg.), which was completely eradicated by the treatment. A lower concentration would undoubtedly have been adequate to control the mite.

GERSDORFF (W. A.), PIQUETT (P. G.) & MITLIN (N.). **The crystalline Isomer of Allethrin as a Standard of Comparison for Fly Sprays.**—*J. econ. Ent.* **49** no. 4 pp. 450–453, 4 refs. Menasha, Wis., 1956.

The following is based on the authors' summary. Further evaluations [*cf. R.A.E.*, B **41** 125] of the relative toxicities to *Musca domestica* L. of allethrin, its crystalline (α-*dl-trans*) isomer and pyrethrins, when applied as sprays in refined kerosene on a turntable, were made in order to obtain information on the chemical stability of the isomer and on the mathematical stability of its toxic relationships. A sample of the crystalline isomer that had been stored in the dark for 38 months had developed a slight yellow colour but was as toxic as one recently recrystallised. A sample stored as a 2 per cent. kerosene solution in the dark for 12 or 38 months also lost none of its toxicity. A comparison of seven estimations of the relative toxicity of the isomer made by the same method, the four in this study and three in the previous one [*loc. cit.*], indicated the ratios of its toxicity to those of allethrin and pyrethrins were 0·29 and 0·74. These ratios were, however, subject to relatively wide variation with different populations of flies, the ranges obtained being 0·25–0·35 and 0·63–1. The knockdown effect of the isomer was high and showed no deterioration after the latter had been stored for 38 months, but was appreciably less than that of allethrin or pyrethrins. The isomer proved no better than several samples of purified allethrin as a standard of comparison in bioassays.

LINDQUIST (D. A.) & FAY (R. W.). **Laboratory Comparison of eight organic Phosphorus Insecticides as Larvicides against nonresistant House Flies.** —*J. econ. Ent.* **49** no. 4 pp. 463–465, 1 ref. Menasha, Wis., 1956.

An account is given of laboratory comparisons of the effectiveness against larvae of the house-fly [*Musca domestica* L.] of eight organic phosphorus insecticides applied as xylene emulsions sprayed on the surface of breeding material. Diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] was the most effective. Applied at 5 mg. per sq. ft., it caused more than 90 per cent. mortality, whether the larvae were small (newly hatched), medium-sized (one day old) or large (three days old). The dosages of parathion, EPN [O-ethyl O-p-nitrophenyl phenylphosphonothioate], Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate] and NPD [tetra-n-propyl dithionopyrophosphate] needed to give an equally good result were 10, 20, 50 and 200 mg. per sq. ft., respectively. Demeton [diethyl 2-(ethylthio)ethyl phosphorothioate], Bayer L 13/59 [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate] and malathion had to be applied at 10 or sometimes 20 mg. per sq. ft. for 90 per cent. mortality of young or medium-sized larvae and failed to give this degree of control of large larvae even when applied at 200 mg. The smallest amounts of Diazinon that caused complete kill when applied against small, medium-sized and large larvae were 20, 5 and 50 mg. per sq. ft., respectively.

Generally, a given dosage of a compound was most effective against the medium-sized larvae and least effective against large ones. None was markedly effective against pupae, even at 200 mg. per sq. ft. When the compounds were applied against small and medium-sized larvae, nearly all the mortality occurred in the larval stage, but when large larvae were treated, a considerable part of the mortality was deferred to the pupal stage, and there was a minor additional effect expressed as defective adults. Action against the emerging adults was prevented by separation of the pupae from the treated medium.

Granett (P.) & Hansens (E. J.). **The Effect of Biting Fly Control on Milk Production.**—*J. econ. Ent.* **49** no. 4 pp. 465–467, 2 refs. Menasha, Wis., 1956.

Dairy herds on two farms in south-western New Jersey were each divided into three groups (A, B and C) of four or five cows almost equally susceptible to attack by biting flies and similar in milk production. Groups A and B in each herd were sprayed weekly from mid-June to the end of August and Group C was the control group. The spray for group A contained 0·5 per cent. methoxy-DDT (methoxychlor) as the only active ingredient, and the spray for group B contained 0·5 per cent. methoxy-DDT and 5 per cent. butoxy polypropylene glycol. The sprays were prepared from emulsion concentrates and applied at the rate of about 1 U.S. quart per cow, but all applications were made in the morning on Farm 1 and all but two in the late afternoon or early evening on Farm 2. The amounts of milk produced per cow of each group on each of the six days after the application of spray, averaged for the lactation periods, and the numbers of biting flies per cow on the first three and sixth afternoons, averaged for seven weeks, are given in tables. The flies were predominantly *Siphona irritans* (L.) and *Stomoxys calcitrans* (L.). The numbers per cow were lowest on group B and highest on group C on each day on both farms, but the differences between groups A and B were not significant, and those between these groups and C were significant only on the first two days on Farm 1 and the first day on Farm 2. There were no significant differences in milk yield on Farm 2, and though groups A and B on Farm 1 gave more milk than C on each day after spraying, the differences in comparison with C were significant only on the second and third days for B and the second day for A. Despite this, the cost of either spray was much less than the value of the associated difference in yield.

O'Brien (R. D.). **The Inhibition of Cholinesterase and Succinoxidase by Malathion and its Isomer.**—*J. econ. Ent.* **49** no. 4 pp. 484–490, 8 graphs, 26 refs. Menasha, Wis., 1956.

Malathion [O,O-dimethyl S-(1,2-bis(ethoxycarbonyl)ethyl) phosphorodithioate] is widely used as an insecticide because it is less toxic to mammals than other organophosphorus compounds. It isomerises on heating, and its *in vitro* anticholinesterase activity, which is low, is increased by this process [*cf. R.A.E.*, B **41** 173]. Further studies on the isomerisation of the compound by heat showed that, except under very mild or very severe conditions, two fractions are produced, a brown supernatant liquid insoluble in water but soluble in organic solvents, and a hard whitish glassy solid that is insoluble in organic solvents but dissolves with crackling and heat on addition of water. The solid was produced in amounts that increased with the severity of heat treatment; its ability to inhibit human plasma cholinesterase was low and about equal to that of malathion, which is not soluble in water. The liquid fraction, here termed isomalathion, was found to

contain a much more potent inhibitor, but intravenous injection of 50 μg. per gm. caused no symptoms in mice. To estimate its stability, the rate of loss of anticholinesterase activity was studied, and its half-life in 50 per cent. ethanol at 25°C. [77°F.] was found to be about 45 hours. Infra-red spectra of malathion, isomalathion and the solid product supported the hypothesis that isomalathion is produced by an interchange between the double-bonded sulphur of the malathion molecule and an oxygen atom of one of the methoxy groups [*cf. loc. cit.*]. The solid appeared to be a mixture of breakdown products, including anhydrous phosphoric acids.

The mode of action of malathion on insects was studied by observing its effects on *Periplaneta americana* (L.). Its LD50 on injection into adult male cockroaches was 8·4 μg. per gm. body weight, and that of its isomer about 60 μg. The symptoms of malathion poisoning resembled those usually produced by organophosphates, but the ataxic phase set in rather rapidly (within an hour) and was unusually prolonged, so that some cockroaches into which malathion had been injected at 10 μg. per gm., though moribund, still showed intermittent tremors after five days, and a similar condition persisted for four days even after doses of 100 μg. per gm. None of the insects recovered, however. In contrast, TEPP [tetraethyl pyrophosphate] caused death within 5–10 minutes. Injection of malathion into *Periplaneta* nymphs caused no changes in respiration. The extent to which the cholinesterase was inhibited in the nerve cords of treated cockroaches was lower five days after treatment than five hours after it, when it was comparable with that caused by TEPP at suitable levels. A further test in which malathion was injected at 50 μg. per gm. showed that the percentage inhibition fell from 61 after two hours to 22 after one day, after which it remained fairly constant for a further three days.

These results suggested that malathion acts primarily on enzyme systems other than cholinesterase, and as it is a derivative of succinic acid [*cf.* **41** 3], its effect on succinoxidase, an enzyme concerned in carbohydrate metabolism, was studied. When house-flies (*Musca domestica* L.) were treated topically with 27 μg. malathion per gm. and frozen after intervals of up to 50 hours (the time required for 50 per cent. mortality), cholinesterase inhibition was at first strong (about 98 per cent.) but fell to about 55 per cent. by the time the insects began to die. Succinoxidase inhibition was only slight (16 per cent. initially). As it was not known whether the activity of these enzymes was affected by the death of the insects and subsequent exposure to normal temperature, flies were killed in three ways and exposed to room temperature for various periods up to three days. In all cases, the succinoxidase level fell with time, but the cholinesterase level remained fairly constant. In *in vitro* tests, isomalathion was a stronger inhibitor than malathion of human serum and erythrocyte cholinesterase, house-fly cholinesterase, mouse liver succinoxidase and house-fly succinoxidase. TEPP did not inhibit rat liver succinoxidase. These results support the view that malathion kills by an anticholinesterase action, though the *in vivo* findings were against it. However, in the latter, total cholinesterase activity was studied, and an increase in this at death might mask the occurrence of a different pattern at a localised and important site of the enzyme. Succinoxidase inhibition was apparently not the cause of death.

Blum (M. S.) & Kearns (C. W.). **The Synergistic Activity of Piperonyl Butoxide applied at different Intervals to Pyrethrum-treated House Flies.**—*J. econ. Ent.* **49** no. 4 pp. 496–497, 11 refs. Menasha, Wis., 1956.

Female house-flies [*Musca domestica* L.] were treated topically on the prothorax with 0·1 μg. purified pyrethrins in 1 μl. acetone per fly and

subsequently treated with piperonyl butoxide either similarly or by injection into the thorax of an emulsion in insect saline. When application of the pyrethrum was followed by topical treatment with 10 μg. piperonyl butoxide after 1, 2, 3, 4, 5, 6, 7 and 8 hours, the percentages of flies knocked down in 30 minutes and (in brackets) dead after 24 hours were 100 (100), 95 (95), 90 (95), 20 (90), 20 (95), 0 (85), 0 (70) and 0 (45). The corresponding figures for 1 μg. piperonyl butoxide were 70 (25), 70 (35), 60 (40), 30 (30), 20 (15), 0 (0), 0 (0) and 0 (0) when it was applied topically, and 90 (65), 95 (60), 85 (70), 20 (60), 0 (30), 0 (35), 0 (30) and 0 (30) when it was injected. Pyrethrum alone caused no knockdown or mortality. Piperonyl butoxide alone caused no knockdown or mortality when topically applied at 1 μg. and no knockdown and 5 per cent. mortality when topically applied at 10 μg. or injected. The ability of the combination of pyrethrum and synergist to produce a good knockdown appeared often to be associated with high mortality.

Smith (G. E.). **Comparative Effect of DDT-treated Houses on introduced *Anopheles quadrimaculatus* Adults, 1944 and 1955.**—*J. econ. Ent.* **49** no. 4 pp. 523–526, 1 fig., 1 ref. Menasha, Wis., 1956.

In view of widespread interest in the development of resistance to DDT by mosquitos, efforts were made in 1955 to repeat some of the experimental house tests made with *Anopheles quadrimaculatus* Say in the Tennessee Valley in 1944 [*R.A.E.*, B **34** 189] and so determine whether, after 12 years' exposure to DDT as house sprays and in other forms, natural populations reacted to exposure in the same way as before. Results in both years showed a wide variation in individual tests in the time needed for complete knockdown or for all the mosquitos to leave treated rooms. The rate of exit was lower in 1955 than in 1944, but, in view of the individual variation, the difference was not significant. Differences in percentage mortality after 4 and 24 hours among those leaving the house were not significant. In general, the results of these limited observations indicate that the behaviour pattern of the mosquitos and their reaction to DDT-treated surfaces remain essentially the same as they were in 1944.

Mitlin (N.), Babers (F. H.) & Barthel (W. F.). **The relative Toxicity and Mode of Action of some Chlorinated Phosphates.**—*J. econ. Ent.* **49** no. 4 pp. 544–546, 11 refs. Menasha, Wis., 1956.

Five esters of 1,2,2,2-tetrachloroethyl phosphoric acid were tested for toxicity to house-flies (*Musca domestica* L.) of a DDT-resistant and a normally susceptible strain and for inhibition of bovine red-blood-cell cholinesterase. The flies were topically treated with acetone solutions of the test compounds. As averages from series of tests, the LD50's of the dimethyl ester in μg. per fly were 0·139 for the susceptible strain and 0·225 for the resistant strain. Taking the toxicity of this ester as 1, the toxicities of the diethyl, dipropyl, diisopropyl and dibutyl esters were 0·75, 0·36, 0·18 and 0·26 for the susceptible strain and 0·84, 0·16, 0·79 and 0·19 for the resistant strain, the diisopropyl ester being thus the only one more toxic to the resistant than to the susceptible flies. The toxicity to susceptible flies of the other esters decreased with an increase in length of the carbon chain in the alkyl group, and it is suggested that the low toxicity to them of the diisopropyl compound was due either to steric hindrance of rotation of the two isopropyl groups or to the fact that, unlike the other esters, it was a crude product. All the esters inhibited the blood cholinesterase, but no definite relationship between chemical structure and cholinesterase inhibition was shown.

It is pointed out that the LD50's of the dimethyl, diethyl and dipropyl esters for susceptible house-flies were equal to or lower than the LD50 of Bayer L 13/59 [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate] found by the same method [*R.A.E.*, B **44** 103].

Sternburg (J.) & Kearns (C. W.). **Pentachlorocyclohexene, an Intermediate in the Metabolism of Lindane by House Flies.**—*J. econ. Ent.* **49** no. 4 pp. 548–552, 4 figs., 10 refs. Menasha, Wis., 1956.

The chlorinated-hydrocarbon insecticides fall into two groups on the basis of resistance to them in house-flies [*Musca domestica* L.]. A strain that has become resistant to a given insecticide shows some resistance to other insecticides of the same group, but practically none to insecticides of the other group [*R.A.E.*, B **44** 111]. However, a DDT-resistant strain can acquire resistance to the BHC group in fewer generations of selection than a normal strain [**42** 55]. This indicates some similarity in the mechanisms responsible for resistance to these compounds. Resistance to DDT is related to the concentration of DDT-dehydrochlorinase in the flies [**45** 29, etc.], though the mechanism by which the enzyme catalyses the elimination of HCl from DDT to form the non-toxic DDE (1,1-bis(p-chlorophenyl)-2,2-dichloroethylene) is not known. DDT-dehydrochlorinase, isolated from DDT-tolerant flies, does not affect γ BHC (lindane), but it was thought that metabolism of the latter might involve the action of a similar enzyme resulting in the elimination of HCl from its molecule, as it is metabolised rapidly by resistant flies and more slowly by normal ones. Bradbury & Standen unsuccessfully sought evidence of the presence of trichlorobenzene in the resistant flies [**43** 187], but if the mechanism of detoxification of γ BHC involves the elimination of only one molecule of HCl to produce PCH (pentachlorocyclohexene), part of the product reported as γ BHC in the flies [**43** 188] may have been a metabolite. Evidence that PCH is an intermediate in the metabolism of γ BHC is given in this paper. It was obtained by the use of spectrophotometric and chromatographic techniques in which the two compounds were distinguished as their nitration products after dechlorination according to the Schechter-Hornstein procedure [*cf.* **42** 27]. The methods used are described in some detail.

Spectrophotometrically, the absorption curve of the chromagen resulting from PCH was identical with the curve of the chromagen obtained from extracts of the internal tissues of resistant flies that had survived for 24 hours after 4 days' contact with a deposit of γ BHC. The absorption curves for the material present externally on such flies or on susceptible flies at any time after topical treatment with γ BHC were similar to those for γ BHC. The curve for extracts of internal tissues of topically treated susceptible flies showed mostly the presence of γ BHC. Chromatograms of the Schechter-Hornstein positive products also showed only γ BHC to be present externally on flies of either strain. Those for extracts of the internal tissues showed γ BHC with only traces of PCH in susceptible flies and two well defined spots, one corresponding to γ BHC and the other to PCH, in resistant flies. PCH appeared in the resistant flies shortly after topical treatment with γ BHC. At first, this compound and γ BHC accounted for the applied dosage, but later there was an increasing loss in the total recovered. The amount of PCH did not continue to increase after the first few hours, probably because it is metabolised to products not responding to the Schechter-Hornstein test. Resistant flies treated topically with 25·5 μg. PCH degraded 60·9 per cent. of the dose within 24 hours while susceptible flies treated with half as much degraded only 13·7 per cent. The loss of recoverable material cannot be wholly attributed to the volatility of γ BHC

and PCH. The rate of absorption of γ BHC increased, within certain limits, with the amount applied and the temperature at which the flies were kept. Susceptible and resistant flies absorbed 0·5 μg. γ BHC at about the same rate.

Bettini (S.) & Boccacci (M.). **Effects of Iodoacetic Acid on the Coenzyme A Content of the Muscle of the American Cockroach.**—*J. econ. Ent.* **49** no. 4 pp. 554–555, 8 refs. Menasha, Wis., 1956.

One of the metathoracic coxae of adult males of *Periplaneta americana* (L.) was removed before and the other after they received injected doses of 180 or 900 μg. iodoacetic acid (two or ten LD50's). Estimates of the content of coenzyme A in the coxal muscle showed that the smaller dose reduced it by 16 per cent. in two hours and the larger one by 19 per cent. in one hour. As ten LD50's iodoacetic acid completely inhibits triose-phosphate dehydrogenase in the coxal muscles of *P. americana* [*R.A.E.*, B **45** 139], it seems likely that inhibition of this enzyme is of more importance in iodoacetic-acid intoxication than inhibition of coenzyme A.

Byers (G. W.), Wheeler (C. M.) & Blakeslee (T. E.). **A Study of Insecticide Resistance in House Flies of Japan and Okinawa.**—*J. econ. Ent.* **49** no. 4 pp. 556–557, 6 refs. Menasha, Wis., 1956.

DDT has been used extensively for the control of *Musca domestica* L. in Japan and Okinawa since 1945. More recently, BHC and γ BHC (lindane) have been adopted in areas of Japan where DDT was no longer giving effective control. Malathion has been used only in limited field studies. The susceptibilities to DDT, γ BHC, malathion and dieldrin of four strains of the fly from Japan and one from Okinawa were determined by topical application. All the strains were moderately resistant to DDT and highly susceptible to dieldrin and malathion. Two Japanese strains, one of which had been exposed to BHC and the other to γ BHC for less than a year, were about ten times as resistant to γ BHC as were the other three strains, which had been exposed to DDT only.

Hawkins (W. B.). **Selection of Larvae of *Anopheles quadrimaculatus* for Tolerance to DDT.**—*J. econ. Ent.* **49** no. 4 pp. 567–569, 2 graphs, 3 refs. Menasha, Wis., 1956.

The BD (Beaver Dam) colony of *Anopheles quadrimaculatus* Say was established in 1952 from larvae collected in a part of Kentucky Reservoir that had been treated with DDT larvicide in eight successive summers and was maintained in the laboratory without exposure to any insecticide. In 1955, a subcolony (BDR) was separated from it, of which the fourth-instar larvae of successive generations were exposed for 24 hours, in groups of up to 500, to alcohol-water suspensions of DDT at concentrations adjusted to keep the kill at 90 per cent. In practice, kills ranged from 70 to 100 per cent. The responses to DDT of the F_1–F_5 BDR larvae were compared with those of BD larvae in parallel tests in which at least 200 larvae of each colony were exposed for 24 hours to each of 13 dosages during a generation, and the dosage-mortality data are given in graphs. The LD50's and LD90's for the BD larvae in the successive tests were 0·0025–0·0038 and 0·007–0·015 parts DDT per million. The BDR larvae showed some increase in tolerance after the F_1 generation, and the LD50 and LD90 for the F_5 larvae were about 0·0076 and 0·025 p.p.m. The evidence of increases in tolerance given by the curves resulted roughly from a rotation of the latter about the point for

complete kill. According to Hoskins & Gordon [*R.A.E.*, B **45** 27], such an increase in slope may denote only a greater vigour among the survivors of a selection, and a population that responds to selection as did this one may lack factors necessary for the development of true resistance. Thus, the data suggest that *A. quadrimaculatus* may be unable to develop resistance to DDT.

Ringel (S. J.). **The Copper Content of resistant and susceptible House Flies.**—*J. econ. Ent.* **49** no. 4 pp. 569–570, 5 refs. Menasha, Wis., 1956.

The enzyme tyrosinase, a copper-protein complex, is associated with the darkening and hardening of arthropod cuticle. It seemed that, if resistant house-flies (*Musca domestica* L.) are more deeply pigmented than others [*cf. R.A.E.*, B **37** 217], they might contain more tyrosinase and hence more copper. To investigate this possibility, flies from a normal laboratory colony and others of a resistant strain that had been exposed to DDT for more than 200 generations were killed by exposure to cold and analysed for copper. It is concluded from the results of the analyses, which are given in a table, that there is a significant difference in copper content on a weight basis between male and female flies in both strains but no difference between the strains.

Fales (J. H.), Bodenstein (O. F.) & Beroza (M.). **New Pyrethrum Synergist. Evaluation of a 3,4-Methylenedioxyphenyl Acetal as Synergist for Pyrethrins and Allethrin against House Flies, Mosquitoes, Roaches, Japanese Beetles.**—*Soap & chem. Spec.* **33** no. 2 pp. 79–82, 8 refs. New York, N. Y., 1957.

An account is given of further tests to evaluate the synergistic activity of 2-(2-ethoxyethoxy)ethyl 3,4-methylenedioxyphenyl acetal of acetaldehyde (ENT-20871) with pyrethrins or allethrin [*cf. R.A.E.*, B **45** 119]. This acetal is identical with "Sesoxane," for which a commercially feasible synthesis has recently been announced. Tests of sprays and aerosols against house-flies (*Musca domestica* L.) and of sprays against mosquitos and the cockroach, *Blattella germanica* (L.), were made by the methods sponsored by the CSMA in 1955 [**44** 25] except that the rate of application in some of the Peet-Grady spray tests, particularly against mosquitos, had to be lower than that prescribed [12 ml. per chamber]. In sprays against house-flies, the acetal was compared with piperonyl butoxide at 2:1, 1:1, 1:2 and 1:4 ratios of pyrethrins or allethrin to synergist. It was more effective than piperonyl butoxide with pyrethrins in the kill effected at all ratios and almost always in knockdown. Increasing the ratio of synergist increased the effectiveness of the spray. In another series of tests, cyclethrin [**43** 56], allethrin and pyrethrins gave 12, 13 and 9 per cent. kill alone, 84, 75 and 93 per cent. with the acetal and 86, 52 and 86 per cent. with piperonyl butoxide, the concentrations of insecticides and synergists being 0·4 and 2 mg. per ml. The OTI (which contains 1 mg. pyrethrins per ml.) gave 40 per cent. kill. The sprays containing the acetal gave virtually the same knockdown in ten minutes as the corresponding ones containing piperonyl butoxide. The Federal Specification Space Spray (0·15 per cent. allethrin, 1 per cent. DDT, 0·8 per cent. synergist and 1 per cent. xylene in deodorised kerosene) gave similar knockdown and kill, irrespective of which synergist was used. The acetal alone at 2 mg. per ml. caused 11 per cent. knockdown and 28 per cent. kill. A spray of the acetal and pyrethrins that was stored in darkness at room temperature in a cork-stoppered bottle for 15 months

caused almost the same kill as a fresh sample but less rapid knockdown. A stored spray of allethrin and the acetal gave much less mortality than a fresh one but the same knockdown.

The acetal and piperonyl butoxide were equal in effectiveness as synergists for pyrethrins in sprays against *Culex pipiens* L. and *Anopheles quadrimaculatus* Say, except that the acetal spray gave the higher kill of females of the Anopheline when the concentrations of insecticide and synergists were lowest (0·1 and 0·5 mg. per ml.). In spray tests against adult females of *B. germanica*, the acetal was more effective than piperonyl butoxide with pyrethrins, but the two synergists were almost equal with allethrin.

In a comparison of low-pressure aerosol formulations containing 0·4 per cent. pyrethrins or allethrin, 2 per cent. synergist, 6·6 per cent. deodorised kerosene, 6 per cent. Velsicol AR-50 and 85 per cent. propellants, the aerosols containing the acetal gave higher knockdown and kill of house-flies than those containing sulfoxide [1,2-methylenedioxy-4-(2-(octylsulphinyl)-propyl)benzene], but the differences in the activity of the synergists were very small with pyrethrins and large with allethrin. After storage for one year at room temperature, both the formulations containing the acetal gave greater knockdown and kill than similar freshly prepared ones. Nearly 16 per cent. more of the stored than of the fresh allethrin aerosol was used, but the dosages of the other two aerosols were nearly equal. In a comparison of four typical low-pressure aerosols that contained either piperonyl butoxide or sulfoxide with similar ones in which the acetal was substituted, the latter caused as good kill as those containing the other synergists and greater knockdown. A medium-pressure aerosol formulation that contains 3 per cent. DDT and 1 per cent. pyrethrins and is licensed for use in aircraft and a modification of it containing 3 per cent. DDT, 0·5 per cent. pyrethrins and 2 per cent. of the acetal were tested against house-flies and Japanese beetles [*Popillia japonica* Newm.]. There was no difference in their effectiveness against the beetles and no difference against the flies except that the aerosol containing the acetal gave the higher knockdown.

Cockroach Spray Test Method.—*Soap & chem. Spec.* Blue Book 1957 pp. 223–224, 6 refs. New York, N. Y., 1957. **The Peet-Grady Method.**—*T. c.* pp. 225–226, 269–270. **Cockroach Aerosol Test Method.**—*T. c.* pp. 227–228, 271, 1 fig., 11 refs. **Aerosol Test Method for Flying Insects.**—*T. c.* pp. 231–232, 270–271, 6 refs. **Tentative Method for Determination of Particle Size Distribution of Space Insecticide Aerosols.**—*T. c.* pp. 233–235, 2 graphs, 5 refs.

Four of these papers comprise descriptions of methods officially or (in one case) tentatively adopted by the CSMA (Chemical Specialties Manufacturers Association) for evaluating insecticides. The requirements for the Peet-Grady method of testing sprays and the method for testing aerosols against flying insects, for both of which the test insect is the house-fly [*Musca domestica* L.], and for the method of testing sprays against cockroaches, for which it is *Blattella germanica* (L.), do not differ from those of the revisions last noticed [*R.A.E.*, B **44** 25].

The cockroach aerosol test method is a tentative method for evaluating insecticides applied directly to cockroaches as liquefied-gas aerosols. In general outline, it resembles the Official Cockroach Spray Method [**37** 101, etc.]. The test insects are last-instar nymphs of *B. germanica* that have acquired their dark pigmentation and have been reared at 75–85°F. and 30–50 per cent. relative humidity. The spray chamber is 18 ins. sq. and 25–30 ins. high and has solid walls, an open top and an open floor covered with hardware cloth and an exterior shelf on which dispensers can be held

in a standard position. The cockroaches are exposed in a screen-bottomed container, 3½ ins. in diameter and 3 ins. high, standing on absorbent paper in such a position on the floor of the chamber that the aerosol mist is directed into the open end. The treatment temperature is 78–82°F., and the period of exposure is 30 seconds, after which the cockroaches are removed and transferred to a recovery dish. The reference insecticide is the OTA, prepared by the CSMA and dispensed from the container in which it is supplied. Any dispenser may be used for an experimental formulation, but the results apply only to the formulation as dispensed from the unit used. Dosage is adjusted so that the OTA gives 50–75 per cent. cockroaches dead and moribund after 48 hours, and 20 test groups of ten cockroaches are used for each insecticide including the OTA. A test sample is reported as meeting the standard unless the percentage of cockroaches dead or moribund after exposure to it is more than 10 below the percentage dead or moribund after exposure to the OTA.

In the method described in the fifth paper for determining the particle size distribution of space insecticide aerosols, the aerosol is drawn into a wind tunnel so that the individual particles settle on a rotating microscope slide. The particles on the slide are counted and classified by size. A suitable correction is applied in order to calculate the particle sizes of the original spherical droplets. The wind tunnel, slide rotator, microscope and accessories and methods of using them and reporting the results are described.

Seshadri (A. R.). **An extraordinary Outbreak of 'Caddice Flies' (Trichoptera) in the Mettur-dam Township Area in Salem District, South India.**—*Indian J. Ent.* **17** (1955) pt. 3 pp. 337–340, 1 fig., 3 refs. New Delhi, 1956.

Trichoptera are only occasionally of importance as pests [*cf. R.A.E.*, B **41** 52, etc.], but *Amphipsyche indica* Martnv. has constituted a considerable nuisance in the Mettur-dam Township area, in southern India, in the past 5–6 years. Breeding occurs in the reservoir and the channels leading from it, and the adults emerge in September – December and are attracted in large numbers to lights in the town, causing annoyance to pedestrians and the drivers of vehicles and making normal indoor life difficult. Their breeding habits are described, and control methods suggested. These include the lighting of bonfires near the breeding places to attract and destroy the adults, the use of powerful fluorescent lamps to localise the infestation, spraying the vegetation on the sides of the channels with DDT to kill the adults, and periodical scraping of larval incrustations off the rocks in shallow water and on partly exposed areas.

Atiqur Rahman Ansari (M.) & Swaleh Nasir (A.). **Human Louse: its Role in the Transmission of Diseases.**—*Pakist. J. Hlth* **5** (1955) no. 3 pp. 119–130, 1 fig., 23 refs. Lahore [1956].

After reviewing the importance of lice (*Pediculus humanus humanus* L. (*P. h. corporis* Deg.)) in the transmission of disease and the history of louse-borne typhus in West Pakistan, where it is frequently reintroduced by migrating Afghans in spite of the existence of frontier posts for DDT dusting, the authors describe a rapid comparative study made in Lahore in May and June 1955 of the effect of various insecticides on lice collected locally in a home for the destitute. Three series of experiments were carried out, each with two cloth patches for each formulation and two control patches, and ten fresh lice were exposed on the patches on three consecutive days. Dusts

were applied at 0·5 mg. per 24 sq. ins. Pyrethrins at 0·04 per cent. and γ BHC at 0·5 per cent. both gave complete kill in all tests. At half these concentrations, they gave complete kill in 16 and 15 of the 18 tests, respectively, and allowed only two or three lice to survive in the others. DDT at 0·1, 0·5, 1 and 5 per cent. gave complete kill in 3, 9, 13 and 16 of the 18 tests, respectively. Mortality among controls was generally 20–30 per cent., but occasionally 70–80 per cent. No regular louse-control measures had been taken in Lahore.

A general discussion of the development of insecticide-resistance in insects forms a concluding section of the paper. It is stated in the course of it that the extensive use of DDT against mosquitos in Lahore has resulted in the development of complete resistance to it in the local strain of *Musca domestica nebulo* F.

Rafi (S. M.). **Resting Places inside Houses of *A. culicifacies* and *A. stephensi*, Malaria Vectors of the Punjab.**—*Pakist. J. Hlth* **5** (1955) no. 3 pp. 146–154, 3 graphs, 9 refs. Lahore [1956].

The resting habits of *Anopheles culicifacies* Giles and *A. stephensi* List., the well-known vectors of malaria in the Punjab, were studied in 1952–55 by recording the heights at which the adults were collected on the interior walls in village houses. The total numbers of *A. culicifacies* and (in brackets) *A. stephensi* taken below, within and above the zone 3–6 ft. from the floor were 2,925 (5,490), 5,718 (10,896) and 7,127 (10,026). The figures for individual villages and months of the year are compared in tables and it is concluded that both species rest at random over the walls, so that the whole surface should be sprayed to ensure effective control.

Komp (W. H. W.). **The Occurrence of *Haemagogus boshelli* in Panama (Diptera, Culicidae).**—*Proc. ent. Soc. Wash.* **57** no. 4 pp. 181–182. 5 refs. Washington, D. C., 1955.

In July 1945, *Haemagogus boshelli* Osorno-Mesa was found in great numbers at a small airfield on the Pacific coast of Panama about 50 miles from the Colombian border. The adults, of which both sexes were collected, were very abundant in the tangle of creepers and aroids on fallen trees in a rice-field south of the runway and in forested areas nearby. The females attacked avidly at ground level at all times of the day, even during showers. The larvae were found in almost all containers of water examined, including tree-holes, fallen palm spathes, fruit husks, coconut shells and tins. The only other places in which *H. boshelli* has been recorded [*R.A.E.*, B **33** 116; **37** 27] are on the Pacific coast of Colombia and it was considered rare.

Any species of *Haemagogus* that attacks man in numbers at ground level is suspect as a possible vector of jungle yellow fever, particularly if it occurs in an endemic area. In 1952, about 100 deaths caused by a fever of unknown etiology but having symptoms resembling those of yellow fever were reported in the native population of an area in Panama not far from where *H. boshelli* was found.

Elliott (R.). **Bio-assay Methods for the Estimation of the Insecticide Residues used in Malaria Control.**—*W. Afr. med. J.* (N.S.) **5** no. 2 pp. 80–87, 1 graph, 6 refs. Ibadan, 1956.

Procedures by which the rate of loss of toxicants from deposits on sprayed surfaces were adequately estimated by bioassay were developed during

Anopheline control work at Ilaro, Nigeria. Deposits were sometimes successfully assayed in the field by exposing fed females of *Aëdes aegypti* (L.) directly to them in batches of ten in perspex funnels attached to the wall by adhesive tape. The females were transferred to the funnels by suction tube, and the mouths were plugged with cotton. After exposure, the mosquitos were transferred from the funnel to a cage under carbon-dioxide anaesthesia and the survivors were counted 24 hours later. Exposure for 15 minutes gave complete mortality on a deposit of BHC wettable powder freshly applied at 15 mg. γ isomer per sq. ft. and decreasing mortality as the deposit aged.

As, however, the technique of using adult mosquitos is troublesome and they are difficult to transport, laboratory bioassay was usually employed. Samples of deposits were satisfactorily removed from mud walls by the use of a scraping tool in an area defined by a metal stencil, and the insecticide was recovered from them with some success by cold extraction with acetone or other organic solvent. The solution obtained could be used immediately for bioassay, or the solvent could be evaporated and the solute later redissolved in a less volatile solvent. The bioassay was usually carried out on first-instar larvae of *A. aegypti*. Their use is recommended because they are remarkably uniform in their reactions, whereas older larvae are not, particularly if they are reared under variable conditions, and also because the eggs from which they are obtained can be stored for long periods and sent by post. Complete hatching of stored eggs is induced by 30 minutes' immersion in warm water. The larvae are exposed to the toxicant in an aqueous dilution of a solution in ethanol or acetone. In the case of DDT, this gives a colloidal suspension, but with BHC and dieldrin, the final dilution is a true solution in water. Not more than 1 per cent. ethanol or 0·4 per cent. acetone in water was used in the work described. Small aliquot parts (usually 1 ml.) of the aqueous dilutions of the unknown extracts and standards prepared from known amounts of toxicant are pipetted into glass tubes, and about 20 larvae are added in the same volume of water. The percentage dead or moribund is ascertained after exposure for about 24 hours. When a consistent set of results has been obtained from the standards, a regression line of probit mortality against log. concentration is plotted, and the concentration in the unknown samples can be read off from this line. The method is not quicker than chemical analysis and is less accurate than the better established chemical methods, though it probably compares well with the cruder colorimetric techniques. Its main advantage is that the insecticidal efficiency of the extracted material is the sole criterion of the amount of toxicant present. Specimen results of estimations of DDT and dieldrin by bioassay and chemical analysis are given, showing that the two methods were in reasonable agreement.

USINGER (R. L.) Ed. **Aquatic Insects of California with Keys to North American Genera and California Species.**—11¼ × 8½ ins., ix + 508 pp., text illus., many refs. Berkeley, Cal., Univ. Cal. Pr.; London, Cambridge Univ. Pr., 1956. Price £3 15*s*.

This work, to which 16 authors have contributed, comprises a general introduction in two parts, one by the editor (pp. 3–49) on the study of aquatic entomology and one by D. Lattin (pp. 50–67) on equipment and technique for collecting, killing, storing and studying specimens and the measurement of chemical and physical factors, a brief general chapter by W. C. Bentinck on the structure of insects and classification, with a key to the 13 orders represented in the insect aquatic fauna, and 13 chapters each dealing with one of the orders. Information is given in these chapters on such subjects as bionomics, habitats, distribution and the collection and

preparation of material, but they are mainly concerned with identification and contain keys (if possible for adults and immature stages also) to all the genera known from North America north of Mexico and to the Californian species. There are abundant text illustrations of important taxonomic characters. The chapter on aquatic Diptera is by W. W. Wirth & A. Stone and occupies 110 pages.

In his introduction, the editor discusses the part played by insects in the aquatic community and adaptations of insects to an aquatic way of life, describes the aquatic habitats of California, and proposes original classifications for the streams and lakes of the State. He also deals with various aspects of applied aquatic entomology, one of the chief of which is mosquito control. The subjects discussed under this heading include survey methods, the use of drainage, larvicides and larvivorous fish, and the relation of water impoundment and irrigation to mosquito breeding and control. A note is also given on the control of *Chaoborus astictopus* D. & S. [*R.A.E.*, B **45** 77, etc.]. Other subjects treated are the bearing of water pollution on insect life, including the part played by insects in sewage treatment, the management of insects in fish culture ponds, and the entomological aspects of stream and lake management.

Cwilich (R.), Mer (G. G.) & Meron (A. V.). **Bedbugs resistant to Gamma-BHC (Lindane) in Israel.**—*Nature* **179** no. 4560 pp. 636–637. London, 1957.

The toxicity of γ BHC to bed-bugs (*Cimex lectularius* L.) received from a children's home in the Beth Shaan valley in Israel, where they were reported to have survived treatment with this insecticide, was compared with that to bugs of a laboratory strain by exposing young adults for constant short periods to a settling atomised spray so that the amounts of γ BHC they received could be increased by increasing the concentration of the spray, the numbers of exposures or both. If the amount that gave 8 per cent. kill of the laboratory strain is considered as one unit, four and 16 units gave 45 and 95 per cent. kill of this strain, but 16 units killed none of the Beth Shaan bugs and 80 units had only about the same effectiveness against them as one unit against the laboratory bugs. The Beth Shaan strain was then reared in the laboratory, and retained a high degree of resistance for several months, being 20–40 times as resistant as the laboratory strain after successive intervals of six weeks.

A sample of bed-bugs from a different (unspecified) part of the country and one from Tiberias proved to be 5–10 and 20 times as resistant, respectively, as the laboratory strain.

Papers noticed by Title only.

Ascher (K. R. S.). **Insect-resistance to Dieldrin. A Survey of the Literature** [on resistance in mosquitos, *Musca domestica* L., *Blattella germanica* (L.) and *Boophilus* spp.].—*Riv. Parassit.* **16** no. 1 pp. 31–40, 55 refs. Rome, 1955. (With a Summary in Italian.)

Doss (M. A.), Humphrey (J. M.) & Segal (D. B.). **Index-catalogue of Medical and Veterinary Zoology. Supplement 6. Authors: A to Z.**—pp. [1+] 1375–1787. Washington, D. C., U.S. Dep. Agric., 1956. Price $1.50 (from Supt. Documents). [*Cf. R.A.E.*, B **44** 211.]

Barrera (A.). **Nota preliminar sobre sifonápteros de *Cynomys* de la zona de enzootia pestosa del sureste de Coahuila, México.** [Preliminary Note on Fleas of *Cynomys* from the enzootic Plague Zone of south-eastern Coahuila, Mexico.]—*Acta zool. mex.* **1** no. 12, 4 pp., 8 refs. Mexico, D. F., 1956. (With a Summary in English.)

Plague has not been found in man or domestic rats in Mexico since 1925 and had never been recorded in wild rodents there until 1954, when G. Varela & A. Vázquez reported the finding of naturally infected prairie dogs (*Cynomys mexicanus*) in the region of Gómez Farías in south-eastern Coahuila. It was, however, present in wild rodents in the United States, including parts of New Mexico and Texas not far from the Mexican border. Ground-dwelling Sciurids are believed to be the chief reservoirs in North America. R. Holdenried & H. B. Morlan isolated the causal agent from six species of fleas collected on *Citellus*, *Neotoma*, *Peromyscus* and *Reithrodontomys* in New Mexico. The fleas infesting *Cynomys* in Canada and the United States are mainly species of *Opisocrostis*, *Thrassis* and *Oropsylla* and occasionally *Pulex irritans* L., but those found by the author on *C. mexicanus* in the part of Mexico in which plague was recorded in it by Varela & Vázquez comprised a few individuals of *Opisocrostis* sp. and many of *P. i. dugesii* Baker with notably constant subspecific characters. As *P. i. dugesii* appears to be a rural form of *P. irritans* that may mix with the type form, it is possible that the maintenance of enzootics of plague in wild rodents and the risk of occasional cases in man near the enzootic zones depend on conditions different from those seen in the countries to the north.

Sasa (M.) & Miura (A.). **Notes on Nymphs and Adults of Tsutsugamushi of Japan, and their Laboratory Rearings. (Studies on Tsutsugamushi, Part 83.)**—*Jap. J. exp. Med.* **25** no. 6 pp. 197–209, 5 figs., 5 refs. Tokyo, 1955.

The nymphs of *Trombicula ichikawai* Sasa and *Euschöngastia miyagawai* Sasa, Kumada & Miura, and the adults of *T. scutellaris* Nagayo et al. and of *T. daisen* Kumada & Sasa (with moulted nymphal skin), are described and compared with those of related species, and a tentative key, often based on very few specimens, is given to the known nymphs of the Trombiculids of Japan. Notes are also given on improved techniques for rearing and studying the mites. All stages after the engorged larvae developed better in plastic petri dishes with hinged lids than in the glass tubes formerly used, as there was more room, better ventilation and less growth of moulds. The substratum was plaster of Paris and charcoal (9:1) solidified with water containing 0·01 per cent. merthiolate. For individual rearing, small open-top plastic tubes were planted in the substratum before it hardened. Unengorged larvae were kept and studied on a cone of plaster of Paris and charcoal in a glass box with water in the bottom and a loosely fitting lid. Resting unengorged larvae of *T. scutellaris* and *T. akamushi* (Brumpt) were found to be stimulated by very dilute carbon dioxide in the air. To collect engorged larvae from living rodents, these were kept (and given sweet potato as food) in a small cage with two layers of plastic screen of about 1 mm. mesh in the bottom, set on a metal funnel fixed in a cup containing a little water. Débris was trapped by the screen, but many of the larvae fell through to the water surface. They were picked up from it with a brush, washed in 0·01 per cent. merthiolate solution and transferred to rearing containers.

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Davis (G. E.) & Hoogstraal (H.). **Étude sur la biologie du spirochète *Borrelia persica*, trouvé chez la tique *Ornithodorus tholozani* (Argasinae) récoltée dans le " Governorate " du désert occidental égyptien. Commentaires sur la distribution et l'écologie de la tique vectrice.**—*Ann. Parasit. hum. comp.* **31** no. 1–2 pp. 147–154, 13 refs. Paris, 1956.

Four lots of *Ornithodoros tholozani* (Lab. & Mégn.), comprising 55, 21, 246 and 36 ticks, were collected in burrows in the western desert of Egypt about a mile to the north-west of Sidi Barrani. They were fed on white mice or guineapigs, individually or in small groups, and transmitted *Borrelia persica* to about 40 of these animals. A marked local specificity was apparent, for 31 individuals of *O. tholozani* from the Soviet Union, 31 from Israel and ten from Jordan failed to transmit the spirochaetes after having fed on guineapigs infected with the Egyptian strain, whereas nine out of 20 individuals from Egypt did so under similar conditions. To ascertain whether the spirochaetes persisted in the foreign ticks that had failed to transmit them, suspensions of batches of ten (including all the Jordan ticks) and of 20, each batch from one country, were injected into guineapigs or mice after 3–4 and nearly 15 months, respectively. The results were positive only for the first of the two batches from Israel and the second of the two from the Soviet Union. Young and adult guineapigs, adult white mice and the Syrian hamster [*Cricetus auratus*] were susceptible to infection to different degrees, but guineapigs were the best host animals [*cf. R.A.E.*, B **45** 12]. It is concluded that *O. tholozani* is a potential vector of relapsing fever in Egypt [*cf.* **44** 108–109].

Notes are given on the distribution, ecology and feeding habits of the tick. It seems to be mainly domestic in some parts of its range and to occur in caves or burrows [*cf.* **33** 18; **40** 7] in others. There are indications that sheep, goats, buffalo, cattle and rodents serve as hosts. In the present work, it was found to be associated with spiny mice (*Acomys*), hedgehogs (*Hemiechinus* or *Paraechinus*) and sand rats (*Psammomys*). It engorges readily on man.

Lovett (W. C. D.). **Eradication of Tick-borne Relapsing Fever in the Somaliland Protectorate by a Tick Destruction Programme.**—*Trans. R. Soc. trop. Med. Hyg.* **50** no. 2 pp. 157–165, 1 graph, 13 refs. London, 1956.

Tick-borne relapsing fever has been eradicated from the Somaliland Protectorate, where it was formerly common, by planned and systematic control of the vector, *Ornithodoros moubata* (Murr.), in settled areas, which were the only centres of infection. This was accomplished by a spraying programme in which the floors of all dwellings and walls to a height of one foot were treated twice at an interval of 4–6 weeks with P.520 (a water-dispersible powder stated to contain 6·5 per cent. γ BHC), diluted with water at 12 oz. per gal. and applied to give a deposit of 10–15 mg. per sq. ft. [*cf. R.A.E.*, B **45** 131–132]. Large-scale treatment was begun in 1949 in Burao, a township comprising some 2,000 houses and huts that was a well-known centre of infection. A third application of spray was made there, though the ticks had apparently been eliminated by the first one. Hargeisa was treated by two applications in 1950–51 and other centres of infection or tick infestation as they were located. The number of cases of relapsing fever in the Protectorate as a whole, which had declined (presumably cyclically) from 625 in 1946 to 216 in 1949 and risen to 265 in 1950 fell to 54 in 1951, 15 in 1952 and 0 in 1953, the last indigenous case being recorded in September 1952. There is thought to be little danger that the

disease will be reintroduced as *O. moubata* usually passes its life near the site of hatching and is thus unlikely to become re-established in cleared settlements.

NILES (W. J.) & SAMARAWICKRAMA (W. A.). *Anopheles hyrcanus* **var.** *nigerrimus* **Giles: a possible Vector of Bancroftian Filariasis in Ceylon.** —*Trans. R. Soc. trop. Med. Hyg.* **50** no. 2 pp. 182–183, 5 refs. London, 1956.

The recognised vector of *Wuchereria bancrofti* in Ceylon is *Culex pipiens fatigans* Wied., and filarial infections detected in *Anopheles hyrcanus* var. *nigerrimus* Giles have been thought to be derived from buffaloes [*cf. R.A.E.*, B **40** 8]. Moreover, Rao & Iyengar have claimed that *W. bancrofti* is generally unable to complete its development in the Anopheline [**20** 232]. To investigate the subject further, laboratory-bred females of both mosquitos were allowed to feed on a patient showing microfilariae of *W. bancrofti*, kept in a saturated atmosphere at room temperature and dissected at intervals of 24 hours. Females of the two species took up roughly the same number of microfilariae, the rate of development of the larvae in them was the same, all fed females were found infected, and those dissected 12½ days after the infecting meal had many living infective larvae in the head or proboscis. These experiments suggest that *A. h. nigerrimus* plays some part as a vector in Ceylon.

PATEL (G. A.) & PATEL (N. G.). **Laboratory Tests on the residual Effect of DDT Water Dispersible Powder against** *Musca nebulo* **Fabricius.**— *Indian J. Ent.* **18** pt. 1 pp. 10–28, 7 figs., 18 refs. New Delhi, 1956.

In experiments designed to select a convenient method of evaluating insecticide deposits, it was found that heavier deposits of dispersible powder, obtained by increasing the concentration of sprayed liquid, took longer to cause 50 per cent. knockdown than lighter ones. Moreover, Barlow & Hadaway reported that DDT dispersible powders caused lower mortality of insects on non-absorbent than on absorbent surfaces, and attributed this to masking of the DDT by the adhesive in the powders [*R.A.E.*, B **36** 20]. As the ability of a wetting agent to enable DDT crystals to adhere strongly to non-absorbent surfaces and thus reduce their effectiveness would complicate the testing of dispersible powders, deposits obtained by applying suspensions of a water-dispersible powder containing 50 per cent. DDT on glass were used to study the relationship between the amount of deposit and its rate of knockdown. The test insects were *Musca domestica nebulo* F., and they were exposed in cages each made of six glass plates that had been treated on a conveyor belt under a Potter spraying tower [**28** 150]. Similarly treated disks of stainless steel were used to measure the deposits, as they could be weighed more accurately than the plates. The cages had an interior sprayed area of 59 sq. ins., and ten flies were used per cage for each test.

In a preliminary experiment in which the deposits were increased by increasing the concentration of the spray, median knockdown time decreased with increased deposit up to 15–25 mg. DDT per sq. ft. but further increases in deposit appeared to reduce the speed of action. Speed of action in relation to increases in deposit obtained by applying increasing amounts of a spray of uniform concentration was then tested. Whether the increased dosage was applied by exposing the plates several times and allowing them to dry between successive sprayings, or by increasing the amount applied

at one time, the trend remained the same. The reduced speed of action of higher deposits became apparent at deposit levels ranging from 12 to 50 mg. DDT per sq. ft. Further experiments revealed that the reduced speed of action of deposits of more than about 35 mg. DDT per sq. ft. was not permanent. When successive groups of ten flies were tested, it lasted for only the first two or three tests. The increased activity of the higher deposits as compared with lower ones in later tests is attributable to the flies themselves [*cf.* **40** 109]. It is clear that the number of flies used in a test in relation to the area of the sprayed surface assumes an added importance.

Naidu (M. B.) & Husain Zaheer (S.). **Physiological Action of Allethrin on Insects.**—*Indian J. Ent.* **18** pt. 1 pp. 57–62, 4 figs., 8 refs. New Delhi, 1956.

The results of studies on the physiological action of allethrin on the isolated heart of *Periplaneta americana* (L.) are given, and its action is compared with that of pyrethrum [*cf. R.A.E.*, A **43** 170] to explain why the latter is a more effective insecticide. The following is virtually the authors' summary. Allethrin at higher and at intermediate concentrations initially depresses the frequency of the heart beat, but later the frequency tends to resume the normal rate. Lower concentrations cause slight initial stimulation, which is followed by a steady decline in frequency. Previous treatment with higher concentrations of allethrin abolishes the action of nicotine (5×10^{-5}) on the heart. Similarly, after prolonged action with nicotine (5×10^{-5}), addition of allethrin does not produce any action on the heart. This indicates that it acts on the cardiac ganglia. Despite previous treatment with allethrin, acetylcholine still produces its stimulant action. Atropine, a cholinergic blocker in vertebrates, is shown to antagonise the action of allethrin. It is suggested that the action of allethrin is due to the release of acetylcholine at the neuro-muscular junctions. Lastly, the superiority of pyrethrum to allethrin in toxicity is shown to be due to the fact that the action of allethrin is confined to the ganglia.

Haynes (H. L.), Lambrech (J. A.) & Moorefield (H. H.). **Insecticidal Properties and Characteristics of 1-Naphthyl *N*-Methylcarbamate.**—*Contr. Boyce Thompson Inst.* **18** no. 11 pp. 507–513, 9 refs. Yonkers, N.Y., 1957.

The authors describe the properties of 1-naphthyl N-methylcarbamate (Sevin) and summarise the results of tests in which it proved highly effective as an insecticide against a variety of insects [*R.A.E.*, A **45** 404–405], but of only limited toxicity to house-flies (*Musca domestica* L.). In cage tests in which the flies were given sugar solution containing the insecticides as their only food, the median lethal concentrations of Sevin, malathion and DDT were 20, 3 and 2 mg. per 100 ml., respectively. Other tests on house-flies indicated that the mode of action of the carbamate was primarily that of an anticholinesterase.

Metcalf (R. L.). Ed. **Advances in Pest Control Research. Volume I.** —9¼ × 6 ins., viii + 514 pp., illus., many refs. New York & London, Interscience Publishers, Inc., 1957.

This is the first of a projected series of volumes comprising reviews of the literature on significant aspects of research connected with the control of pests including injurious arthropods, fungi and weeds. The authors are

to be selected from specialists in the various fields, and critical evaluation of new concepts and developments is to be encouraged, so that new lines of research are fostered. The articles in this first volume include: **Control of Health Hazards associated with the Use of Pesticides,** by J. M. Barnes (pp. 1–38, 136 refs.), in which the toxic properties of insecticides and the risks attending their manufacture and use are reviewed; **Uses of Radioisotopes in Pesticide Research,** by P. A. Dahm (pp. 81–146, 2 figs., 323 refs.), in which the subjects discussed include the use of labelled insecticides in research, tagging insects, mites and ticks with radioisotopes, and the control of *Callitroga hominivorax* (Coq.) by the release among natural populations of males sterilised by irradiation of pupae; **The Chemistry and Action of Organic Phosphorus Insecticides,** by T. R. Fukuto (pp. 147–192, 4 graphs, 143 refs.), in which the author reviews the nature of the enzymes (esterases) inhibited by organic phosphates and the mechanisms of their reversible and irreversible inhibition, and the relation of the structure of the phosphates to their activity and their metabolism in biological systems, and concludes that organophosphorus compounds of high anticholinesterase activity may be classified as those that contain only one reactive bond connected to the phosphorus atom, or that can be metabolised by an animal or plant to give such a compound, and those that resemble the natural substrate, acetylcholine, either by their overall configuration or by the presence of a cationic site at a precise distance from the ester moiety; **Repellents for biting Arthropods,** by G. F. Shambaugh, R. F. Brown & J. J. Pratt jr. (pp. 277–303, 110 refs.); **Chemical Analysis of Pesticide Residues,** by M. S. Schechter & I. Hornstein (pp. 353–447, 455 refs.); and **Bioassay of Pesticide Residues,** by Yun-pei Sun (pp. 449–496, 111 refs.), in which the author reviews methods of bioassay using insects or other organisms and factors that affect the results.

Imms (A. D.). **A general Textbook of Entomology, including the Anatomy, Physiology, Development and Classification of Insects.** Ninth edition entirely revised by O. W. Richards & R. G. Davies.—10 × 6 ins., x + 886 pp., 613 figs., many refs. London, Methuen & Co., Ltd., 1957. Price £3 15*s*.

The first edition of this well-known textbook appeared in 1925 [*R.A.E.*, B **13** 56]. Of the subsequent editions, only that published in 1934 [**22** 81] represented a substantial revision, but this has since become increasingly out of date. The work has therefore been completely revised in the light of the literature published mainly up to 1952, and parts of it, notably those on insect physiology, extensively rewritten. References are now grouped at the end of each chapter.

Reid (E. T. M.). **Some Observations on** *Glossina morsitans ugandensis* **Vanderplank in the Sudan.**—*Acta trop.* **12** no. 3 pp. 193–221, 7 figs., 32 refs. Basle, 1955. (With Summaries in French and German.)

Race *ugandensis* Vanderplank of *Glossina morsitans submorsitans* Newst. [*cf. R.A.E.*, B **40** 143] is widely distributed in the southern Sudan, and there are five small "islands" of infestation by it to the north of the main tsetse belt. One of these, in the Koalib Hills [*cf.* **17** 59] is of little economic importance, but the other four, known collectively as the Jur Narrows group, are ridges in flood plains and are in the path of cattle on their annual migration to grazing grounds on these plains, which also cover extensive areas to the east. Cattle passing the islands contract trypanosomiasis, caused by *Trypanosoma congolense* or *T. vivax*, from the

tsetse there, and the disease is also thought to be spread mechanically in the plains by other blood-sucking flies. An account is given of the position with regard to the tsetse infestation in Galual and Nyang, two of the Jur Narrows islands with areas of 100 and 45 square miles, respectively, before reclamation was begun there in 1953. There are five main vegetation zones in the islands: the flood plain, which is almost treeless and forms a perfect barrier to the spread of tsetse, low-lying areas with scattered *Mitragyna inermis*, light thorn savannah, intermediate thicket, and deciduous savannah ridges. Climatic conditions are severe during the dry season (October–April) when the temperature frequently exceeds 40°C. [104°F.], and the fly cannot survive this season in the thicket in Galual, but survives where *M. inermis*, which is almost evergreen, retains its foliage. Game animals of various kinds provide a readily available food-supply, and fly and game both return to the ridges and higher thickets during the rains. Whether fly movement depends on that of game or whether both depend on climatic conditions has not been proved. In Nyang, which is much lower than Galual, the thickets retain foliage longer and the tsetse can survive in them, but it and game are both scarce, probably owing to disturbance of the bush by native settlers and hunters.

Over 800 pupae and more than 2,000 empty puparia were collected under *M. inermis* in the dry season. One-tenth of the pupae were non-viable owing to desiccation or, once the heavy rains set in, to excess moisture. Breeding is probably widespread on higher ground during the wet season. Only eight of the pupae found were parasitised. Three parasites that emerged were *Thyridanthrax abruptus* (Lw.), and the other five, which died before emergence, were apparently of the same genus. Freshly engorged flies were found resting near the bases of *M. inermis*. Old males and teneral flies bit man eagerly. Females did so less readily, but bit more on hot days than on cool ones. This perhaps indicated greater activity due to a shortening of the hunger cycle by high temperatures. Of 50 adults of both sexes dissected, two had trypanosomes in the proboscis and three others had them in the salivary glands and ducts.

Herbig-Sandreuter (A.). **Experimentelle Untersuchungen über den Cyclus von *Trypanosoma rangeli* Tejera 1920 im Warmblüter und in *Rhodnius prolixus*.** [Experimental Observations on the Cycle of *T. rangeli* in warm-blooded Animals and in *R. prolixus*.]—*Acta trop.* **12** no. 3 pp. 261–264, 4 figs., 5 refs. Basle, 1955.

Observations on a strain of *Trypanosoma rangeli* sent from Caracas in 1950 by Pifano were made in 1952–53 at San Juan, Porto Rico. Injection of cultures of the trypanosome caused acute parasitaemia followed by a latent phase in baby mice and latent infection only in *Macaca mulatta* (*Macacus rhesus*). There were no symptoms of illness or histopathological changes in either mice or monkeys. No tissue forms were found in more than 1,000 sections cut from mice, only occasional blood forms, indistinguishable from those occurring in the peripheral blood, being found in liver and heart blood of heavily parasitised animals. All attempts to transmit *T. rangeli* to mammals through the faeces of infected individuals of *Rhodnius prolixus* Stål have failed [but *cf. R.A.E.*, B **42** 178], and the author attributes the failure to the scarcity of metacyclic forms in the faeces. Heavy infection in the faeces of *R. prolixus* was obtained by feeding the bugs on cultures rich in parasites. The enriched faeces were infective to two out of 20 new-born mice on subcutaneous injection but were not infective when put on the intact or scarified skin. The author observed a massive infection of the haemolymph with crithidia, dividing forms and

metacyclic stages, associated with weak intestinal infection in ten adults that had fed on infected mice some weeks earlier, and the salivary glands also contained numerous trypanosomes [*cf.* **43** 85, etc.]. This shows that *T. rangeli* could be transmitted to mammals by bite [*cf.* **42** 87].

Boshko (G. V.). **Contribution to the Question of the Carriage of Fleas of Rodents by Dogs.** [*In Russian.*]—*Zool. Zh.* **35** pt. 1 pp. 74–76, 11 refs. Moscow, 1956. (With a Summary in English, suppl. pp. 7–8.)

In 1946, sheep-dogs in Transbaikalia were found to be infested by fleas known to be the parasites of marmots (*Marmota sibirica*), and the fleas also occasionally attacked the men who looked after the dogs. After this, a man who visited the steppe three times a day to inspect traps set near the burrows of various rodents, took a sheep-dog with him, but did not allow it to enter the burrows. The dog was combed for fleas before and after each visit, and those found were *Pulex irritans* var. *fulvus* Ioff (small form), *Oropsylla silantiewi* (Wagn.) (a parasite of *M. sibirica*), *Archaeopsylla sinensis* J. & R. (a parasite of hedgehogs), *Pectinoctenus pavlovskii* (Ioff) (a parasite of *Microtus brandti*) and *Frontopsylla luculenta* (J. & R.) (a parasite of *Citellus dauricus*). The dog was then kept away from the steppe, but casual combing twice a day resulted in the finding of 1–2 fleas daily for ten days. The observations confirmed records of the migration of rodent fleas on the surface of the soil [*cf. R.A.E.*, B **27** 170; **30** 144; **31** 85, etc.], since the dog could have been infested only by such fleas. It was attacked chiefly in the early morning or late evening, which is in conformity with the diurnal activity of the fleas, and all those found on it belonged to species with well developed eyes [*cf.* **27** 170].

Zverev (A. N.). **A Plough-trap for Mites.** [*In Russian.*]—*Zool. Zh.* **35** pt. 1 pp. 155–156, 1 fig. Moscow, 1956.

A description is given of a device for collecting Trombiculids from grass. It is mounted on a wheel and pushed by means of a long handle. It is made of two triangular pieces of plywood on a frame and a U-shaped piece of strong wire. Strips of metal are fixed to the plywood to form grooves, and the two triangles are attached on opposite sides of the lower end of the handle so as to slope downwards from it. The U-shaped wire is fixed above them with the open end projecting forwards. The device is pushed rapidly through the grass for a few yards at a time, and the mites are shaken into the grooves, from which they are tipped on to a sheet.

Hitchcock (L. F.). **Studies on the parasitic Stages of the Cattle Tick, *Boophilus microplus* (Canestrini) (Acarina: Ixodidae).**—*Aust. J. Zool.* **3** no. 2 pp. 145–155, 2 graphs, 10 refs. Melbourne, 1955.

The following is partly based on the author's summary. Studies were made at Yeerongpilly, Queensland, on infestations of *Boophilus annulatus microplus* (Can.) established by single applications of large cultures of larvae to cattle. The cattle were taken from uninfested pastures and kept in concrete-floored stalls protected by an oil-covered moat from invasion by tick larvae from outside. Engorged larvae, unfed nymphs, engorged nymphs and unfed adults were observed 3·3–8·7, 4·5–13·1, 9·7–20·3 and 11·9–21 days after the cattle were infested, and 50 per cent. of the larvae and of the nymphs had moulted 5·5 and 13·9 days after attachment of the larvae. Male nymphs moulted, on the average, somewhat earlier than female nymphs. Adult males were still present up to 70 days after attachment of the larvae to the cattle, but engorged females fell after 18·9–35·5 days.

50 per cent. having fallen by 21·9 days. Climate has little effect on the duration of the stages on cattle.

A diurnal rhythm in the fall of engorged ticks was demonstrated, most falling between the hours of 6 and 10 a.m. The cattle were fed at 8 a.m. and this probably involved some disturbance, so that host activity may have been a factor influencing the time of peak fall [*cf. R.A.E.*, B **43** 146]. There is considerable natural mortality of all stages of the tick on cattle. The importance of the life-history studies to toxicological work is discussed.

Hitchcock (L. F.). **Studies of the non-parasitic Stages on the Cattle Tick,** *Boophilus microplus* **(Canestrini) (Acarina: Ixodidae).**—*Aust. J. Zool.* **3** no. 3 pp. 295–311, 2 graphs, 18 refs. Melbourne, 1955.

The following is virtually the author's summary. Laboratory studies of the effects of temperature and relative humidity on the non-parasitic stages of the cattle tick, *Boophilus annulatus microplus* (Can.), are described. The pre-oviposition period ranged from 19–39 days at 59–60°F. to 2–3 days at 97°F. The duration of oviposition was not influenced by relative humidity but varied from a maximum of 44 days at 59°F. to a minimum of four days at 102°F. The minima at each temperature were exceedingly irregular, due to the deaths of ticks. The number of eggs laid by a female tick was not influenced by relative humidity. The peak oviposition mean of 2,496 eggs per female occurred at 75°F., fewer eggs being laid at higher and lower temperatures. Daily egg output attained a maximum of 197 at 92°F., but was not influenced by relative humidity. The water loss of engorged females was greatly affected by inert dusts, and even dusting with a sample of soil chosen at random produced a significant increase in water loss.

The duration of the egg stage was not influenced by order of deposition, but percentage hatch of eggs laid during the last few days of oviposition was lower. Eggs did not hatch at constant relative humidities lower than 70 per cent., but some could survive relative humidities lower than this if exposed periodically to a saturated atmosphere. The period of development of eggs varied from a maximum of 146 days at 62°F. to a minimum of 14 days at 97°F. Maximum hatch occurred between 85 and 95°F., and at relative humidities above 95 per cent. Exposure of eggs to temperatures below the developmental zero prolonged the period of development merely by the period of exposure. Regular alternation of temperature between the limiting temperatures of 59 and 97°F., with a steady rise or fall between the extremes, resulted in development at a rate approximately equal to that obtained at constant temperature of 78°F., the arithmetic mean of the above figures. Length of larval life was influenced markedly by temperature and humidity. A maximum of 240 days was recorded at 72°F. and 90 per cent. relative humidity. Larvae could recoup water losses sustained at low relative humidity by absorption from the atmosphere during subsequent periods of high relative humidity.

Webber (L. G.). **The Relationship between larval and adult Size of the Australian Sheep Blowfly** *Lucilia cuprina* **(Wied.).**—*Aust. J. Zool.* **3** no. 3 pp. 346–353, 7 graphs, 8 refs. Melbourne, 1955.

The following is the author's summary. Quantitative formulations are derived for the relationships between the adequacy of larval food, the weight of puparia, the length of thorax of adult flies, the number of ovarioles in adults, and the size and weight of eggs produced by adults of *Lucilia cuprina* (Wied.). Smaller adults grown from starved larvae lay fewer eggs, but mature eggs from flies of widely differing sizes vary little in

size and weight. The number of eggs laid per batch provides a good indication of the number of ovarioles present. There is no evidence of resorption of eggs retained in the ovaries, but the eggs are no longer viable after 17 days, and histological examination shows that breakdown of the eggs has taken place.

Metselaar (D.). **Variations in the Sporozoite Rate of Anophelines of the *punctulatus* Group.**—*Docum. Med. geogr. trop.* **8** no. 4 pp. 363–364, 3 refs. Amsterdam, 1956.

In an experiment in the Nimboran valley, 40 miles from Hollandia in Netherlands New Guinea, six catches of Anophelines, each lasting 5–12 days, were made at intervals throughout 1954 on man in the evening and on the inner walls of native houses during the day. The predominant species and the only ones in which malaria parasites were found, were three members of the *punctulatus* group (*Anopheles punctulatus* Dön., *A. farauti* Lav. and *A. koliensis* Owen); and the sporozoite rates for the group in the daytime and evening collections were 1·3 and 0·2 per cent., respectively, the difference being significant. Adults of this group are active from sunset to dawn, particularly after midnight. As Anophelines that have oviposited early in the night try to obtain a blood-meal in the second half of the same night, a batch caught late in the night probably comprises a larger proportion of older females than one collected early. The percentage of females of the *punctulatus* group staying indoors after dawn was significantly greater among those that entered an experimental hut after midnight than among those that entered earlier. Therefore, a batch of these or other exophilic mosquitos collected indoors in daytime would probably include more older and sporozoite-positive females than a batch collected on man in the early evening. This might explain the difference observed. The suggestion was supported by observations made in 1955, when the sporozoite rate in females caught indoors by day was compared with that in females taken on man throughout the night. The men acting as bait imitated the behaviour of the local people, first sitting out of doors or on the open gallery of the house and later retiring indoors. The sporozoite rates were 1·1 and 1·6 per cent., respectively. The difference was not significant, but the rate for the mosquitos caught on man throughout the night was significantly higher than that for the evening catch in 1954.

Bonne-Wepster (J.). *Culex bitaeniorhynchus* **as Vector of** *Wuchereria bancrofti* **in New-Guinea.**—*Docum. Med. geogr. trop.* **8** no. 4 pp. 375–379, 23 refs. Amsterdam, 1956.

S. L. Brug & H. de Rook identified the microfilariae responsible for filariasis at Inanwattan, Netherlands New Guinea, as *Wuchereria bancrofti* [*R.A.E.*, B **21** 145]. In 1955, de Rook made a survey of the mosquitos of a village near Inanwattan, in which many of the population suffer from elephantiasis and have microfilariae in their blood; he found no Anophelines, but dissection of other mosquitos caught in houses showed fully developed larvae of *W. bancrofti* in *Culex bitaeniorhynchus* Giles, *C. annulirostris* Skuse and *Mansonia uniformis* (Theo.). The author examined the mosquitos that were collected and not used for dissection and others reared from larvae collected in and near the village, and found that they included some 17 species of which all but the three already mentioned appeared to be of little importance because they were either scarce or zoophilous. *C. bitaeniorhynchus* was the most abundant mosquito in the houses, appeared to feed on man by choice, and was found breeding in a swamp, often between rush-like vegetation but with no algae present. Its habits thus differed from those recorded

for the species; records of breeding places are divergent, but the Indonesian form hardly ever attacks man [*cf.* also **40** 215]. Notes are given on the variability in colour characters shown by Indian specimens of *C. bitaeniorhynchus* in the British Museum and those collected by de Rook and by forms of the species, some of which have been named as varieties, in other parts of its range. The terminalia show little variation, and it is suggested that *C. bitaeniorhynchus* may represent a species-complex, but that the members of this complex should, at present, be considered conspecific.

Gunewardene (K.). **Observations on the Development of *Dirofilaria repens* in *Aedes* (*Stegomyia*) *albopictus* and other common Mosquitoes of Ceylon.**—*Ceylon J. med. Sci.* **9** pt. 1 pp. 45–53, 1 pl., 4 figs., 8 refs. Colombo, 1956.

The following is based on the author's summary of investigations on the development of *Dirofilaria repens*, which is very common in dogs in Ceylon but of which the vector in the field is not known, in laboratory-bred females of mosquitos likely to be vectors. The development of the larval stages in *Aëdes albopictus* (Skuse) is described. The larvae migrate within half an hour to the Malpighian tubules, where they develop to the infective stage. Between the eighth and the tenth day, they migrate fairly rapidly to the head and proboscis, probably through the connective tissue of the thorax. Development to the infective stage was more rapid and successful in *Mansonia* (*Taeniorhynchus*) *uniformis* (Theo.) and *M.* (*T.*) *annulifera* (Theo.) than in *A. albopictus*, and was also completed in *A. aegypti* (L.), *Armigeres obturbans* (Wlk.), *Anopheles hyrcanus* var. *nigerrimus* Giles and *A. barbirostris* Wulp. No infection was obtained in *Culex pipiens fatigans* Wied., *Anopheles vagus* Dön., *A. subpictus* Grassi or *A. jamesii* Theo., and *C. tritaeniorhynchus* Giles and *C. gelidus* Theo. would not feed on the dog used as a source of the microfilariae.

Steyn (J. J.), Rose Innes (R.) & Hechter Schulz (K.). **A Culicine Mosquito Survey of the upper Limpopo River Valley.**—*J. ent. Soc. S. Afr.* **18** no. 2 pp. 238–246, 1 map, 7 refs. Pretoria, 1955.

In a mosquito survey of the Transvaal side of the upper Limpopo valley, made in March 1953, 408 larvae of 18 species and 130 adults of 14 species were taken. In all, six species of *Anopheles*, nine of *Aëdes* and six of *Culex* were represented. The species of *Aëdes* included three, *A. aegypti* (L.), *A. metallicus* (Edw.) and *A. vittatus* (Big.), that are known or believed to be vectors of yellow fever in other parts of Africa [*cf. R.A.E.*, B **32** 25, etc.]. Only the last was at all numerous, being represented by five larvae and 48 adults. The only other species of which more than 50 examples were taken were *A. fulgens* (Edw.) (231) and *Culex nebulosus* var. *pseudocinereus* Theo. (98). *Anopheles gambiae* Giles was represented by 23 larvae and three adults. The species taken in each locality searched are shown in a table with the habitats in which they were found, and an analysis of their breeding and resting places is made.

Tahori (A. S.), Sterk (V. V.) & Goldblum (N.). **Studies on the Dynamics of experimental Transmission of West Nile Virus by *Culex molestus*.**—*Amer. J. trop. Med. Hyg.* **4** (1955) no. 6 pp. 1015–1027, 1 graph, 16 refs. Baltimore, Md., 1956.

West Nile virus is widespread in the Middle East [*R.A.E.*, B **45** 102, etc.] and gives rise to inapparent or unrecognised infections in Egypt and

to an epidemic disease, West Nile fever, in Israel [**43** 19]. There is evidence that species of *Culex* or *Aëdes* may be vectors of the virus [*cf.* **31** 203; **43** 21, 49, 71] and experiments by Olejnik, who worked with what has now been identified as West Nile virus, indicated that *C. pipiens molestus* Forsk., in particular, may transmit the disease in Israel [**43** 20]. This is the most widespread house-dwelling *Culex* there, and it is abundant in areas where West Nile fever occurs. Its ability to become infected and to transmit the virus by biting was therefore investigated further. The strains of virus used had been isolated from the blood of patients in Israel, and passaged a few times in mice, and the titres of suspensions of infected mouse brains or mosquitos were the dilutions at which they were estimated to infect 50 per cent. of mice by intracerebral inoculation of 0·03 ml.

When the titre of the suspension on which the mosquito fed was 10^{-4} or more, the mosquitos transmitted virus to suckling mice after an extrinsic incubation period of 7–28 days, but no transmission occurred when the titre was $10^{-2\cdot8}$, even though virus was present in the mosquitos. These results are in agreement with those of studies on the transmission of the virus of yellow fever by mosquitos [**37** 228; **41** 59]. The percentage of mice infected by bite seemed to be a function of the length of the extrinsic incubation period. The percentage of mosquitos feeding on mice was lowest on the seventh day after the infective meal, probably because many were still gravid or had only just oviposited. After this, it fluctuated between 20 and 40 per cent. The titre of virus in infected mosquitos varied considerably in different experiments. It fell during the first few days following the infective meal and fluctuated between $10^{-2\cdot2}$ and $10^{-5\cdot7}$ after 9–28 days. It was found that an infected mosquito pool might be composed of individual mosquitos having virus titres ranging from $10^{-3\cdot5}$ to less than 10^{-1}. Though each mosquito feeding on a suspension having a titre of 10^{-5} or more became infected, only those with a titre of $10^{-1\cdot5}$ or more, and only half of those, could transmit the infection by biting after a suitable incubation period. The amount of virus injected into suckling mice by the bite of infected mosquitos was found to correspond to about 1,000 subcutaneous ID50's. The distribution of virus in the tissues of suckling mice at different times after subcutaneous inoculation of the virus or the bite of infected mosquitos is shown in a table.

Henderson (J. M.). **Water Management Planning for Malaria Prevention in the Damodar Valley, India.**—*Amer. J. trop. Med. Hyg.* **4** (1955) no. 6 pp. 1091–1102, 5 figs. Baltimore, Md., 1956.

The Damodar Valley Corporation was set up in 1948 to impound water for flood control, production of hydroelectric power, irrigation and other purposes. The scheme involves the formation of four large reservoirs with fluctuating water levels and two minor barrage ponds of more or less constant level in the upper part of the area, mostly in Bihar, and a lower irrigation area extending over one million acres in West Bengal. Its possible effects on Anopheline breeding and measures that should be taken to reduce this are discussed. The rainy season (south-west monsoon) extends from June to October, the cool season from November to February and the hot season from March to May, and the main malaria transmission season is July–November in the upper zone and July–December in the lower. The chief vector in the upper zone is *Anopheles culicifacies* Giles, which breeds in shallow sunlit often temporary water, and in the lower *A. philippinensis* Ludl., which breeds in permanent water with vegetation (mainly the small reservoirs in the villages). Both occur in an intermediate zone, which includes one of the barrage ponds. Secondary or suspected vectors include

A. pallidus Theo., *A. ramsayi* Covell, *A. annularis* Wulp and *A. stephensi* var. *mysorensis* Sweet & Rao. *A. fluviatilis* James is present in the upper zone only, and may be a secondary vector towards the end of the main transmission season and a primary vector in the season of low-level transmission. It was expected that impoundment would reduce the prevalence of this species.

The four reservoirs should not present a problem during the early monsoon period when the rapid rise in water level submerges most of the marginal pools and inhibits Anopheline production in the main pools. Heavy discharges in accordance with the main objective of flood control can provide sharp surges during this period in the two barrage ponds. When the reservoirs have risen to their full storage levels during the latter stages of the monsoon, they will tend temporarily to become constant-level pools and should not give rise to significant Anopheline production, but when rainfall and flows decline, the two barrage ponds may present a substantial hazard. Suggested measures are clearance of trees and brush within and immediately beyond full pool levels on all impoundments, filling of natural depressions between high and low water levels, and periodic fluctuation of the water level in the barrage ponds. A special problem was posed by the numerous rice-fields in the areas affected by the fluctuating water level of the reservoirs. Rice was grown in these in the monsoon season and often dry crops on the lower terraces in the dry season. Pre-impoundment breaking of the rice-field bunds was considered desirable, but would have been prejudicial to the agricultural interests. Finally, breaking only those bunds that would still be submerged on 15th December, the last planting date for the dry crops, was recommended.

The potential malaria hazard created in the irrigation area is very much greater than that created by the reservoirs. The confirmed vector is *A. philippinensis*, but *A. culicifacies* is present in small numbers. Opinion is divided as to whether, on the theory that production of *A. philippinensis* is inversely proportional to the height of the water table, this should be raised as far as possible, or whether such a policy would encourage *A. culicifacies* and application of the minimum amount of water, together with maximum drainage and other conservation irrigation measures, should be recommended. A summary is given of five intensive field studies that are considered desirable to provide data on which to base the choice of countermeasures.

GILLIES (M. T.). **The Density of Adult *Anopheles* in the Neighbourhood of an East African Village.**—*Amer. J. trop. Med. Hyg.* **4** (1955) no. 6 pp. 1103–1113, 1 map, 13 refs. Baltimore, Md., 1956.

The following is largely based on the author's summary. Previous observations on the habits of *Anopheles gambiae* Giles and *A. funestus* Giles at Tengeni, a village in the low-lying area of Tanganyika, showed that they feed almost exclusively on man and that only 5 per cent. of the biting population appears to rest outside after feeding [*R.A.E.*, B **42** 118–120], so that the total numbers of freshly fed females resting in all houses in the area in the daytime comprise the overwhelming majority of the biting population of the previous night. Spray-catching in all the houses in the village was therefore undertaken during the first 12 days of December 1952 to ascertain the total size of this biting population, and the total numbers of females at all stages of ovarian development were estimated from it. The catches yielded nearly 28,000 mosquitos from 120 houses, including 6,325 freshly fed females of *A. gambiae* and 4,832 of *A. funestus*, which represented 35·2 fed females per head of human population per day over

the period of the operation. The total number of females of *A. gambiae* and *A. funestus* in the village was estimated at about 30,000 (15,000 of each species). As the area investigated was 380 acres, this represented about 40 females of each species per acre. The outside resting population was estimated at 14–15 females per acre of each species. The annual range of fluctuation in density was estimated from observations on the biting population in an experimental hut, in which catches were made throughout the year. The density of females per acre at different seasons was estimated to vary between 2 and 48 for *A. gambiae*, and between 0·5 and 78 for *A. funestus*. These results indicate that the very high rate of malaria transmission in the area is maintained by relatively small numbers of mosquitos, because of their exceptionally close contact with man and their long life and short gonotrophic cycle in a favourable climate [*cf.* **43** 62].

Neghme (A.), Gutiérrez (J.) & Alée (R.). **Attempt to eradicate *Anopheles* in the Malaria Zone of Chile.**—*Amer. J. trop. Med. Hyg.* **4** (1955) no. 6 pp. 1114–1118, 1 map, 5 refs. Baltimore, Md., 1956.

The former malaria zone in Chile was confined to the valleys and oases situated between latitudes 18 and 21° south in the Province of Tarapacá, and the only species of *Anopheles* there was *A. pseudopunctipennis* Theo. [*cf. R.A.E.*, B **31** 97; **36** 52]. A campaign against it was begun in July 1937 at the city of Arica, extended later to the nearest valley and in 1941 to the remaining valleys, oases and chasms of the Province. Weekly application of petroleum to breeding places, marsh drainage and filling, repair of irrigation canals and control of springs, together with naturalistic measures and distribution of *Gambusia affinis*, were the principal methods used until July 1944, when house spraying with DDT against the adults became the chief measure, combined with the use of DDT emulsified solutions containing 0·2 or 0·4 per cent. DDT against the larvae. Rates of application in house-spraying ranged from 0·1 gm. per sq. m. four times a year at first to 2 gm. per sq. m. once a year at the end. BHC was also used from 1949. In 1945 and 1946, domestic animals were sprayed about every two months with 0·05 per cent. DDT in emulsified solution to kill any Anophelines that might feed on them.

The campaign was a success before the application of DDT, which consolidated the gains that had already been made. No case of locally acquired malaria has been recorded in Chile since April 1945, and no adults of *A. pseudopunctipennis* have been taken since the autumn of 1948, but a few larval foci with early instars have been found in the valleys nearest the Peruvian border. Since 1951, house-spraying has been confined to the area round the breeding foci discovered. It is possible that these foci have their origin in adults carried by traffic from Peru. To achieve eradication, control and vigilance would have to be maintained for a long time and combined with agricultural work to facilitate the elimination of breeding places.

In conjunction with anti-Anopheline activities, DDT and BHC have been applied to rivers for the control of Simuliid larvae with good results.

Haines (T. W.). **Breeding Media of common Flies. II. In rural Areas.** —*Amer. J. trop. Med. Hyg.* **4** (1955) no. 6 pp. 1125–1130, 3 refs. Baltimore, Md., 1956.

Investigations in rural areas (three communities each with a population of about 1,000) in south-western Georgia showed that *Musca domestica* L.

bred in a greater variety of naturally occurring refuse than did any of the other flies found. The methods used in the study, which lasted from May 1952 to the end of April 1953 were the same as in one in urban areas, and the 20 kinds of breeding media found were grouped into the same five categories [*R.A.E.*, B **43** 46]. *M. domestica* was produced in 19 of the 20 materials throughout the period of study. No other species approached it in terms of number of infestations or variety of media used. Animal pen litter, animal wastes, animal excrement, fruit and vegetable wastes and miscellaneous wastes were observed, respectively, 1,781, 633, 1,986, 309 and 705 times. The percentages of these categories of media infested with larvae of flies and (in brackets) the average numbers of adults reared per sample from them were 66·4 (31·4), 19·6 (108·1), 56·4 (58·3), 27·8 (57) and 44·4 (32·1), respectively. Corresponding figures are given for individual species or genera of flies; for *M. domestica* they were 31·9 (32·5), 0·8 (6·4), 8 (60·2), 8·4 (55·5) and 17·3 (20·6). The miscellaneous wastes, in which considerable breeding occurred, comprised garbage and slop-soaked soil arising from the common practice of disposing of washing and dish water near the back doors of houses. As in the urban areas, the occasional high production of species other than *M. domestica* in certain breeding materials was offset by the relatively infrequent occurrence of the medium or by its being infested by only one or two species of flies. Paunch manure and packing plant wastes were of minor importance in the rural environment.

Haines (T. W.) & Palmer (E. C.). **Studies of Distribution and Habitat of Cockroaches in southwestern Georgia, 1952–53.**—*Amer. J. trop. Med. Hyg.* **4** (1955) no. 6 pp. 1131–1134, 11 refs. Baltimore, Md., 1956.

In a survey of 12 towns in south-western Georgia, cockroaches were trapped in three environments (in dwellings, outside dwellings and in and near privies) in each month from August 1952 to July 1953 and in sewer manholes during January–July. The common species were *Blattella germanica* (L.), *Periplaneta americana* (L.), *P. fuliginosa* (Serv.) and *P. brunnea* Burm., and all were trapped in each environment, but *B. germanica* comprised 86·6 per cent. of the catch in dwellings [*cf. R.A.E.*, B **43** 150]. *P. fuliginosa* consistently outnumbered all other species trapped outside dwellings and was the predominant species frequenting privies. *P. americana* comprised 99 per cent. of cockroaches in sewer manholes, and also occurred in some numbers inside dwellings and in or around privies. Only one example of this species was trapped outside a dwelling, and its distribution suggests that population pressure in sewerage systems [*cf.* **44** 162] may drive it to move to the less favourable environment of the home, either through plumbing traps [*cf.* **44** 46] or by direct flight.

P. americana and *P. brunnea* were more abundant and *B. germanica* less abundant during the late spring and summer than during the cooler months.

Thompson (H. V.). **Myxomatosis: a Survey.**—*Agriculture* **63** no. 2 pp. 51–57, 1 map, 3 refs. London, 1956.

Brown (P. W.), Allan (R. M.) & Shanks (P. L.). **Rabbits and Myxomatosis in the North East of Scotland.**—*Scot. Agric.* **35** no. 4 pp. 204–207, 7 refs. Edinburgh, 1956.

Lockie (J. D.). **More Light on Myxomatosis.**—*Op. cit.* **36** no. 1 pp. 44–45.

The spread of myxomatosis of rabbits in Britain and on the Continent and its status in Australia are reviewed in the first paper. The disease first

became established in Europe when two artificially inoculated rabbits were released in France in June 1952. It had spread over practically the whole of France by the end of 1953, killed some 90 per cent. of the rabbits there in 1954 and had become enzootic by 1955. Many domestic rabbits were affected in 1953–54 but few subsequently. *Anopheles maculipennis atroparvus* van Thiel was probably an important vector. The disease had also spread to Belgium, Germany, Luxembourg, the Netherlands and Spain early in 1954, reached Switzerland later that year, and Austria and Italy in August 1955. Reported cases in some of these countries have been mainly among domestic rabbits.

Myxomatosis was introduced into south-eastern England by unknown means and was first notified in October 1953. Attempts were at first made to eradicate it, but it spread at the rate of 3½ miles per month and was established at twelve places in the south-eastern counties by the spring of 1954. It was recorded from Wales in May and from Scotland in July, its spread in these cases having undoubtedly been helped by the transfer of diseased rabbits to uninfected areas. Most of England and Wales south of a line from the Wash to the Wirral peninsula was affected by the end of 1954, and every county in northern England had some infection. Deliberate spreading of the disease by transfer of infected rabbits was made an offence in November. Virulence remained high, generally with a mortality of about 99 per cent., through 1955, and the disease was present in most parishes in Great Britain by the end of the year. After an epidemic, sporadic cases continued to occur among the depleted population.

The principal vector in Britain in 1954 and 1955 was the rabbit flea (*Spilopsyllus cuniculi* (Dale)). Rabbits remained numerous on the island of Skokholm off the Pembrokeshire coast, where they were free from fleas, but nearly all were destroyed on the neighbouring island of Skomer, where the fleas were present. Woodland mosquitos were shown not to be attracted to healthy rabbits in either year and can have played little, if any, part in transmission. Relatively few domestic rabbits were affected by the disease, but several outbreaks were associated with *A. m. atroparvus*, infected females of which were found in the same hutches as diseased rabbits. This mosquito can live through the winter, feeding occasionally, and the virus can survive in it for over six months, but since no infected females were caught outside hutches, it is unlikely that it was an important vector.

Attenuated strains of virus, with mortality rates of 90 per cent. or less, are present in most infected areas of Australia, and repeated attempts to replace them by a fully virulent strain have been unsuccessful. Vectors have more opportunity of acquiring the attenuated virus, as infected rabbits remain ill for about three weeks instead of only one. However, the summer of 1954–55 was very favourable for transmission, and rabbit populations were reduced to their lowest level for over 50 years. The disease is enzootic almost everywhere in Australia where rabbits are found, and there is generally an epizootic each year. Its activity depends mainly on the production of large numbers of mosquitos, which remain the chief vectors [*R.A.E.*, B **42** 77, etc.]. This in turn depends on an increase in the area of surface water after heavy rain. The principal transmitting species are *Anopheles annulipes* Wlk. and *Culex annulirostris* Skuse. *A. annulipes* feeds on rabbits above ground at night and also attacks them in their burrows during the day, whereas *C. annulirostris* bites at night only. Apart from mosquitos, only Simuliids have proved to be important carriers in Australia, capable of spreading the disease for distances of over 50 miles.

Attenuated strains were isolated in April 1955 from wild rabbits in the English Midlands and from a domestic rabbit in central France and later from wild rabbits in Hampshire. There are now, apparently, no really heavy

rabbit infestations on the mainland of England and Wales, but some moderate ones exist. The greater part of the country is covered by rabbit clearance areas, authorised in 1954, where every effort is made to control the remaining rabbits by traditional methods.

In the second paper, the course of myxomatosis infection in Scotland after its deliberate introduction in 1954 is reviewed. It spread slowly but appeared sporadically in different areas in the north. This strongly suggested human intervention and natural spread by *Spilopsyllus cuniculi*. This flea and the sheep tick [*Ixodes ricinus* (L.)] have both transmitted the virus in laboratory tests, but the tick is not likely to have spread infection extensively, as the rabbit is not its normal host. There are no known instances of transmission by mosquitos in Scotland, but in June 1955 an infected rabbit was found in Upper Deeside with three adults of *Simulium reptans* (L.), a species not uncommon in the north and west of Scotland, biting its ears. Shortly afterwards, diseased rabbits were found 40 miles away in an area so remote that human interference was unlikely. This and many widespread outbreaks in western Scotland during the warm summer of 1955 could be explained by the activities of such a flying vector. Experimental rabbits introduced into a warren in winter 50 days after the last rabbit had died from myxomatosis became infested with fleas and developed the disease. When the rabbits were introduced after 70 days, fleas were later found on them but no infection appeared. In four similar attempts made in summer, 90 days after the death of the last rabbit, neither infestation with fleas nor infection with the virus followed, but the experimental rabbits may not have penetrated the does' nests. Attempts to exterminate rabbits on the Heisker Islands in the Hebrides with myxomatosis virus failed through the absence of biting insects to spread the infection.

It is stated in the third paper that spread of the disease in Britain may have been hastened by the carriage of infected fleas by mammals and birds predacious on rabbits and, in particular, that herring gulls have almost certainly carried them from the mainland to islands. The life-history of *Spilopsyllus cuniculi* is not fully known. The larvae live on excrement, dried blood and refuse, and when fully developed, spin cocoons in which they may remain dormant for months. The adult can exist without a blood-meal for months, but needs a meal on its true host before fertile eggs can be laid. The greatest concentrations of fleas are usually found in rabbits' nests rather than on their bodies. R. M. Lockley found the number of fleas on individual rabbits to vary from 0 to 270. In very cold weather, fleas congregate in the fur between a dead host and the ground, but in warm weather, they search for another host near the carcase. The grey-squirrel flea [*Orchopeas wickhami* (Baker)], which can be made to feed on rabbits, can acquire the virus and retain it for 20 days.

Jacquemin (P.) & Ferrandez (R.). **Les larves de** *Dermestes undulatus* **Brahm peuvent être nocives pour l'homme.**—*Bull. Soc. Hist. nat. Afr. N.* **46** no. 7–8 pp. 280–281, 2 refs. Algiers, 1955.

Eight of the dockers who unloaded a cargo of skins and organic fertilisers at a North African port in the morning developed extensive cutaneous lesions with intense irritation on their hands, arms, feet and legs. The dermatitis was so severe that they sought medical advice on the same day, but their general health was not affected, their temperature remained normal, and the symptoms were short-lived and disappeared without sequelae. The condition was found to be due to the action on sensitive subjects of the hairs of last-instar larvae of *Dermestes undulatus* Brahm, with which the cargo was heavily infested.

Sokolova (N. Yu.). **The lowest and highest Temperature for Mortality of the Bed-Bug** (*Cimex lectularius* **L.**). [*In Russian.*]—*Éktoparasitŷ* no. 3 pp. 113–125, 2 graphs, 8 refs. Moscow, Mosk. Obshch. Ispŷt. Prir., 1956.

Details are given of the results of laboratory experiments in Moscow in which large numbers of eggs, nymphs of each instar and adults of both sexes of *Cimex lectularius* L. were exposed to heat or cold for various periods. In tests at four low temperatures, all stages survived exposure for up to five days at −7 or −10°C. [19·4 or 14°F.], and all were killed by exposure for 15 minutes at −32°C. [−25·6°F.]. All stages except the first-instar nymphs were killed by three hours' exposure at −18°C. [−0·4°F.], but 24 hours' exposure was required for complete kill of first-instar nymphs, though they remained torpid for about three days after exposure for 12 hours. The eggs were less resistant than the other stages; few survived after five hours at −7 or −10°C., and none after two hours at −18°C. Adults collected in dwellings were less resistant than adults reared at a constant temperature and exposed to cold immediately after moulting. The females were less resistant than the males, and hungry adults less resistant than those that had fed immediately before the test. First-instar nymphs reared from the eggs of females brought from the south of the Soviet Union showed reduced resistance to cold, exposure to −18°C. for two hours resulting in complete mortality.

Resistance to heat was tested in a saturated and a dry atmosphere. In the saturated atmosphere, the periods of exposure to temperatures of 42, 44, 46, 48 and 50°C. [107·6, 111·2, 114·8, 118·4 and 122°F.] that gave complete kill of all stages were 120, 30, 7, 3 and 2 minutes, respectively, nymphs in the earlier instars being more resistant than older ones, adults or eggs. In the dry atmosphere, complete mortality of adults and nymphs (all of which were in the second instar) was obtained by exposure to the same temperatures for 90, 35, 8, 4 and 4 minutes, respectively, and eggs were equally or more susceptible at all temperatures, except 42°C., at which they required 150 minutes' exposure for complete kill.

Berlin (L. B.). **Of the Changes in the striated muscular Fibres of the Skin due to the Effect of Feeding by the Tick,** *Hyalomma asiaticum* **P. Sch. et E. Schl. (Fam. Ixodidae).** [*In Russian.*]—*Dokl. Akad. Nauk SSSR* **111** no. 6 pp. 1348–1351, 1 pl., 20 refs. Moscow, 1956.

A detailed account is given of investigations on the effects of the feeding of adults of *Hyalomma asiaticum* Schulze & Schlottke, on the striated muscular fibres of the skin of guineapigs and rabbits. Sections of the muscular tissues taken in various phases of the feeding of the tick showed the presence of two kinds of necrosis in them, one characterised by a lamellar and the other by a columniform structure, accompanied by the development of oedema and ecchymotic spots in all layers of the skin, and local disturbances in metabolism and probably also in the functions of the nerves innervating the muscular fibres. These changes are attributed to the combined effect of the local toxicity of the saliva, the presence of oedema and ecchymosis in the intermuscular connective tissues, and the general toxicity of the saliva to the whole organism.

Pavlovskiĭ (E. N.) & Skrŷnnik (A. N.). **Contribution to the Biology of the Tick,** *Ornithodorus papillipes*. [*In Russian.*]—*Dokl. Akad. Nauk SSSR* **111** no. 6 pp. 1403–1405, 3 refs. Moscow, 1956.

An account is given of further laboratory observations in the Soviet Union [*cf. R.A.E.*, B **41** 185, etc.] on the length of life and resistance to starvation

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of *Ornithodoros tholozani* (Lab. & Mégn.) (*papillipes* (Bir.)) and on the persistence of relapsing-fever spirochaetes in it.

A batch of 46 individuals collected in the Pamirs in 1936 was allowed to feed on a guineapig on 19th January 1937. All but two engorged, and the guineapig became infected with spirochaetes. The next feed took place on 15th March 1940, when the survivors (five adult males, four females and 31 nymphs), all engorged. The guineapig remained uninfected. Five nymphs were still alive on 15th March 1950, and three of them were then allowed to feed; two engorged and the other died. Those that had fed moulted, one to an adult female and the other to the next nymphal instar. They were fed again in March 1954. In January 1955, the nymph died, but the adult female was still alive. One of the two nymphs that had not fed since 1940 died at the beginning of 1951, and the other was allowed to feed on 9th April 1951. It moulted to an adult female in the second half of the year and was allowed to feed on a white mouse in February 1955. It was still alive on 23rd April 1956 and became active on exposure to light, but died a day later.

Another batch of 210 individuals collected in the same region in 1937 was allowed to feed on a guineapig on 15th February 1938, and the guineapig became infected. The next feed was on 5th August 1940, when eight males, ten females and 169 nymphs engorged, two ticks did not feed, and all the others died. The guineapig became infected. Four nymphs engorged on 18th November 1948, all the other ticks died, and the guineapig remained uninfected. Two nymphs engorged on 19th March 1954, and the other two died. The nymphs subsequently moulted, one to an adult female and the other to the next-instar nymph. Both were still alive in 1956. In other tests on ticks collected in 1936, one female out of a batch of 12 individuals that fed 11 times, one male out of a batch of 168 that fed 12 times, and one female of *O. lahorensis* Neum. out of a mixed batch of 110 examples of this tick and *O. tholozani* that fed seven times were still alive in 1956. The ticks have thus shown ability to survive in the laboratory for 20 years, and reproduction of *O. tholozani* has occurred there after 17, 18 and 20 years.

Adult ticks have been considered unable to preserve spirochaetes in their bodies for long, but when examples of *O. tholozani* that had been collected in Tadzhikistan in September 1937 and had failed to infect the guineapigs on which they fed in 1938, 1940 and 1944 were fed on an infected animal in October 1946, one male infected a guineapig in August 1951, two failed to do so in April 1953, and one did so in September 1954, though a negative result was obtained in April 1956. The ability of the ticks to preserve the spirochaetes throughout their life, independently of stage, is of more importance, however, and when ticks that had hatched in 1939 from eggs laid by infected females were fed ten times in the next 17 years, they infected the guineapig on each occasion except the first, when they were still in the larval stage, and the last, in April 1956, when only five males were still alive.

Neeman (M.), Mer (G. G.), Cwilich (R.), Modiano (A.) & Zacks (S.). **Studies in selective Toxicity. III. Benzenesulphonanilides as DDT-synergists.**—*J. Sci. Fd Agric.* **8** no. 1 pp. 55–64, 7 figs., 30 refs. London, 1957.

The 39 benzenesulphonanilides used in the experiments described in this paper had halogen or methyl substituents in the phenyl rings, and 25 of them had N-alkyl substituents. Two of the latter had no halogen substituents and were inactive; the other 23 were the subject of a previous paper [*R.A.E.*, B **45** 89–90] from which some of the main results for them have already been noticed.

None of the compounds showed toxicity to *Cimex lectularius* L. when tested as a spray, none of the N-alkyl series was toxic to rats when tested by administration of 500 mg./kg. by stomach tube or intraperitoneal injection, and only two showed any appreciable toxicity (which was less than that of DDT) to a moderately DDT-resistant strain of *Musca domestica vicina* Macq., but several showed high activity when tested for synergism with DDT against this strain. Those that did included the N-n-alkyl compounds up to octyl and some of the others, but they were tested in various ways and differed in relative activity according to the method of test. The synergists superior by one or both of two test methods to DMC (di(p-chlorophenyl)methylcarbinol), indicated by the numbers by which they are cited in the authors' text, were IX (4-fluoro-benzenesulphon-4′-fluoroanilide), X and XIV (4-chloro- and 4-bromo-benzenesulphon-4′-chloroanilides), XV (N-methyl-X), XVI (N-methyl-XIV), XVIII (N-ethyl-XIV) and XXVII (N-n-hexyl-XIV). The DDT : synergist ratio was 10 : 1 and the percentages of flies knocked down in three hours after brief successive contact with deposits of synergist and DDT and (in brackets) of flies killed by topical application [*cf. loc. cit.*] were increased from 13 (5·5) for DDT alone to 60 (62) by DMC, 78 (61) by XXVII, 70 (75) by XV, 66 (64) by XIV, 62 (82) by XVI, 56 (71) by X, 52 (72) by XVIII and 37 (76) by IX.

A spray test of the synergistic activity of some of the compounds was also made, and the most effective were a group of eight of the N-n-alkyl compounds (including XXVII) with chain lengths ranging from propyl to octyl. The most effective of the other compounds in this test was X. The DDT : synergist ratio in the sprays was 1 : 1.

The activity of most DDT-synergists previously reported has been attributed to their structural similarity to DDT. It has been suggested that the synergistic action of DMC and also of synergists of the diphenylamine and benzenesulphonanilide types is due to competition between synergist and DDT for the enzyme (DDT-dehydrochlorinase) responsible for converting DDT to DDE [**43** 28]. Moorefield & Kearns, however, found that DMC was not attacked by the enzyme and that its action on the latter was irreversible, and concluded that it functioned as an inhibitor in an additional manner and not competitively [**44** 100]. The present study has afforded some findings bearing on the mode of synergistic action of benzenesulphonanilides. It has been confirmed that symmetrical substitution in both para-positions, by fluorine (IX) or by chlorine (X), enhances the intrinsic synergistic activity. However, the effects of changes in the central part of the molecule on its synergistic activity are not parallel to those observed in the activity of DDT and of its close analogues. The synergistic activity of N-alkyl-benzenesulphonanilides up to octyl is in sharp contrast to the complete inactivity of DMC homologues studied by Speroni [**43** 27]. Unpublished work by S. Cohen has shown that one of them (XVI) inhibits DDT-dehydrochlorinase *in vitro*, so that this inhibition may be a factor in their synergistic activity, but their differences in structure from DDT and numerous active synergists appears to indicate that the inhibition is not of the competitive type.

Lindquist (D. A.) & Dahm (P. A.). **Metabolism of radioactive DDT by the Madeira Roach and European Corn Borer.**—*J. econ. Ent.* **49** no. 5 pp. 579–584, 4 figs., 29 refs. Menasha, Wis., 1956.

The following is substantially the authors' summary. The absorption, metabolism and excretion of ^{14}C-ring-labelled p,p′DDT in adult females of the Madeira cockroach (*Leucophaea maderae* (F.)) and fifth-instar larvae of the European corn borer (*Pyrausta nubilalis* (Hb.)) were studied. The

cockroach absorbed DDT rather slowly (about 90 per cent. in 20 days) and excreted 50 per cent. of the total applied radioactivity over a period of 36 days. Separation of the radioactive compounds excreted in faeces by DDT-treated cockroaches was accomplished by paper chromatography. The presence of DDT, DDE (2,2-bis(p-chlorophenyl)-1,1-dichloroethylene) and three unidentified metabolites was demonstrated. DDT was the predominant radioactive compound excreted in the first 24 hours after treatment, after which a metabolite with an R_f value of about 0·88 was the major one. Metabolic pathways for DDT in the cockroach are proposed.

Fifth-instar larvae of *P. nubilalis* have some tolerance of DDT and convert significant amounts of absorbed DDT to DDE. No evidence of DDT metabolites other than DDE was found. Both colorimetric and radiometric analyses were used in the study of *P. nubilalis*.

Rai (L.) & Roan (C. C.). **Effects of Piperonyl Butoxide on the Anticholinesterase Activities of some organic Phosphorus Insecticides on House Fly and purified Bovine Erythrocyte Cholinesterases.**—*J. econ. Ent.* **49** no. 5 pp. 591–595, 7 refs. Menasha, Wis., 1956.

The following is substantially the authors' summary. The effects of piperonyl butoxide on the anticholinesterase activities of malathion, Diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] and Bayer L 13/59 [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate] on cholinesterase from a normally susceptible and a DDT-resistant strain of *Musca domestica* L. and purified bovine erythrocyte acetyl cholinesterase were investigated *in vitro* by colorimetric means. A significant decrease in cholinesterase inhibition was found wherever malathion was used in combination with piperonyl butoxide. This lower anticholinesterase action of malathion, due to the presence of piperonyl butoxide, was more pronounced on the purified acetyl cholinesterase than it was on the fly cholinesterase. The decreased inhibition of the acetyl cholinesterase was associated with the higher ratios of piperonyl butoxide.

The *in vivo* effects of piperonyl butoxide in protecting house-fly cholinesterase from inhibition by malathion were investigated at varying intervals after the topical application of piperonyl butoxide solution in acetone to individual flies. The results six hours after treatment suggest that piperonyl butoxide protects the cholinesterase against the inhibitory actions of malathion. No protective effect was found 16 hours after the application of piperonyl butoxide. Diazinon and Bayer L 13/59, in combination with piperonyl butoxide, gave synergistic toxic effects by topical applications, and no indication of anticholinesterase inhibition was observed in the *in vitro* tests. The contrasting effects of piperonyl butoxide on different organic phosphorus insecticides suggest differences in their mode of action [*cf. R.A.E.*, B **45** 111–112].

Webb jr. (J. E.) & Graham (H. M.). **Observations on some Filth Flies in the Vicinity of Fort Churchill, Manitoba, Canada, 1953–54.**—*J. econ. Ent.* **49** no. 5 pp. 595–600, 1 ref. Menasha, Wis., 1956.

During studies in 1953 and 1954 in the neighbourhood of Fort Churchill, Manitoba, on the insects that might be of importance in the transmission of enteric diseases in arctic and sub-arctic areas, 27 species of filth flies (non-biting flies associated with human waste) were recorded, and considerable information was obtained on their seasonal occurrence, abundance, biology and habits. Fort Churchill is situated at latitude 58°47′N. on the west shore of Hudson Bay and has a mean annual temperature of 17·8°F. and average temperatures of about 53°F. in July and August and −19°F.

in January. Much of the information, some of which is the subject of this paper, was obtained from catches made in conical fly-traps baited with human faeces, cooked meat, sweetened milk or fruit and operated in summer during the season of fly activity. This activity became considerable in the middle of July, was very high in late July and early August, and dropped sharply in late August and September. Faeces attracted nearly all the species of flies that were attracted to the other baits and usually in much larger numbers. Data for the 13 most prevalent species taken in two traps baited with faeces and operated on two or more days each week from 11th June to 17th August 1953 are given in a table. The most plentiful were *Phormia* (*Protophormia*) *terraenovae* R.-D. and *Cynomyia* (*Cynomyopsis*) *cadaverina* R.-D., of which 6,014 and 2,420 individuals were taken, respectively. In 1954, these species made up about 87 per cent. of the catch, which was low, in a trap set up near the garrison mess. Filth flies were not a nuisance or health problem in summer bivouacs or fishing camps. *C. cadaverina* and *P. terraenovae* occurred in enormous numbers at a garbage disposal area half a mile from Fort Churchill, and *Musca domestica* L. was abundant there in late July and August. However, none of these species occurred in noticeable numbers in homes or messes less than a mile away, though large numbers of the two Calliphorids were collected in traps several miles from known breeding areas. Only one adult of *M. domestica* was trapped at a distance from the garbage disposal area; it was in a faeces-baited trap at a winter bivouac site five miles from Fort Churchill. Early in June 1953, adults of the Calliphorids were seen ovipositing on the carcass of a dog at the garbage dump and later in June on meat scraps and other exposed garbage. Both were extremely numerous in late July and in August, particularly *P. terraenovae*. *Hydrotaea bispinosa* (Zett.) appeared in the first week in July and became the third most abundant species late in the month.

The two Calliphorids and *M. domestica* are believed to be the most important potential vectors of enteric diseases in the area, and laboratory tests in which examples of each species were allowed access to a culture of *Salmonella typhosa* for 24 hours and the organism was subsequently cultured from suspensions of them showed that it could be carried for one day by *C. cadaverina* and for up to five and six days by *P. terraenovae* and *M. domestica*, respectively. *P. terraenovae* bred extensively in animal carcasses and garbage and, to a smaller extent, in human faeces. There was some evidence that it overwintered in the adult as well as in the larval, prepupal and pupal stages. *C. cadaverina* was more abundant than *P. terraenovae* in meat-baited traps and sometimes more abundant in faeces-baited traps more than three miles from the garbage dump. It was also found breeding in carcasses and waste meat. It was not a serious pest indoors, nor was it a nuisance where food was being prepared outdoors. There were indications that it overwintered in the prepupal stage. Collection data are given on the other species taken, with notes on seasonal abundance in some cases.

Collins (W. E.). **The Effectiveness of Pyrethrum and Allethrin Formulations in a Thermal Fog Machine.**—*J. econ. Ent.* **49** no. 5 pp. 610–611, 1 ref. Menasha, Wis., 1956.

The following is almost entirely based on the author's summary. To determine the loss in toxicity of formulations of pyrethrum and allethrin when passed through a Swingfog insecticide applicator [*cf. R.A.E.*, B **44** 130], samples of the fog were collected and tested against formulations not subjected to the fogging process by bioassay on larvae of *Aëdes aegypti* (L.).

Under the conditions tested, pyrethrum and allethrin showed highly significant losses in toxicity as a result of the fogging treatment, but the loss for mixtures of allethrin and synergist varied with the synergist.

Guyer (G. E.), King (H. L.), Fischer (R. L.) & Drew (W. A.). **The Emergence of Flies reared from Grass Silage in Michigan.**—*J. econ. Ent.* **49** no. 5 pp. 619–622, 4 refs. Menasha, Wis., 1956.

Increased populations of flies, principally *Musca domestica* L. and *Stomoxys calcitrans* (L.) were evident during an investigation of fly control in dairy barns at Michigan State University, and it was found that grass silage near the barns was providing a breeding medium for several species. Structural adaptations in the storage containers such as open-bunker types and self-feeding upright silos, have increased the exposed surface area available for larval development. The adoption of self-feeding of hay and silage in and near loose-housing buildings has also provided favourable conditions for the development of concentrated populations. Investigations in 1954 and 1955 indicated that the number and species of fly larvae in silage depended on several ecological factors. The most important of these appeared to be the moisture content of the silage, while the type of construction of the storage structure, the type of preservative added, the area of silage exposed and the method of feeding also had an influence. Populations of larvae generally developed in the drainage areas where excess moisture collected, in the outer 8 ins. of exposed silage when enough moisture was present, and in feeding areas where silage became mixed with manure and débris. *M. domestica* and *Chrysomyza demandata* (F.) made up 44 and 31 per cent., respectively, of the 1,810 flies identified from the silage samples, which represented 20 species and ten families. *S. calcitrans* made up less than 4 per cent. *M. domestica* was the most widely distributed species and was almost the only one in a very wet putrid drainage area. *C. demandata* occurred predominantly at the top of the silage. It was not possible to associate any species of fly with definite species of herbage in the silage. There was a seasonal variation in the total population and in its species composition. Larvae were most numerous in the second week of July. The inability to provide satisfactory fly control in buildings closely associated with the storage of silage may often be explained by the concentrated populations present in the silage adjacent to dairy barns.

Goodwin (W. J.) & Gressette jr. (F. R.). **Residual House Fly Control in Dairy and Beef Barns in South Carolina.**—*J. econ. Ent.* **49** no. 5 pp. 622–624, 8 refs. Menasha, Wis., 1956.

In experiments made in South Carolina in 1954 and 1955 to develop practical and inexpensive ways of applying insecticide deposits for the control of house-flies [*Musca domestica* L.], 64 dairy barns with average sanitation and seven barns housing beef cattle and having a high fly-breeding potential were sprayed by either the overall or the spot method [*cf. R.A.E.*, B **41** 175]. The overall sprays were applied at 1 U.S. gal. per 250–275 sq. ft. with a hydraulic sprayer or a device attached to a garden hose. In the spot method, a hydraulic sprayer was used to apply half the quantity of a double concentration spray. House-fly populations were low during 1954 because of extremely dry weather, but both weather conditions and house-fly breeding were normal in 1955. In the latter year, satisfactory control for an average of four weeks or more was obtained with suspensions of wettable powders containing 25 per cent. Diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate], 50 per cent. Am.

Cyanamid 4124 [O,O-dimethyl O-2-chloro-4-nitrophenyl phosphorothioate] or 25 per cent. Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate], all at 16 lb. per 100 U.S. gals. for overall spraying, and also with emulsion sprays containing 1 per cent. Am. Cyanamid 4124 or 2 per cent. of a concentrate cited as Malrin emulsion (containing 35 per cent. Perthane [ethyl-DDD] and 18 per cent. malathion [*cf.* **43** 182]). A wettable powder containing 25 per cent. Chlorthion [O,O-dimethyl O-3-chloro-4-nitrophenyl phosphorothioate] at 32 lb. per 100 U.S. gals. was effective for an average period of three weeks. In the first year, satisfactory control was generally maintained longer. The period of control obtained in the beef-cattle barns was generally about half that obtained in the dairy barns, but the Chlorthion spray gave satisfactory control for four weeks. The sprayer attached to a garden hose (which is designed for liquid insecticides only) was found to provide a practical and inexpensive way of applying the emulsions. The duration of control was the same as that obtained when they were applied by hydraulic sprayer. The spot and overall methods of application also gave satisfactory control for the same length of time.

Raun (E. S.). **Chicken Louse and Mite Control with Malathion Formulations.**—*J. econ. Ent.* **49** no. 5 pp. 628–629, 11 refs. Menasha, Wis., 1956.

The following is based on the author's summary. Field tests to determine the effectiveness of malathion in the control of *Dermanyssus gallinae* (Deg.) and lice on fowls were carried out in Iowa during the summer of 1955. The lice were *Menacanthus* (*Eomenacanthus*) *stramineus* (Nitzsch), *Menopon gallinae* (L.) and *Goniocotes gallinae* (Deg.). A spray containing 1 per cent. malathion prepared from an emulsifiable concentrate was applied to walls, ceilings, roosts and nests in buildings housing laying flocks, at the rate of 1 U.S. gal. per 1,000 sq. ft. A dust containing 4 per cent. malathion was applied to the litter of two similar houses, at 1 lb. per 20 sq. ft. Both the dust and spray gave complete control of the mites for the whole observation period of 45 days and also of the lice except in one house where the hens were shut out while the spray was being applied. Egg production records showed an increase of 20–50 per cent. when the mites and lice were eradicated. Residue analyses showed no malathion remaining in hens killed seven days after they had been treated in a sack with the spray at 5·5 oz. per bird or the dust at 0·5 oz. per bird.

Burden (G. S.) & Cole (M. M.). **Effectiveness of Cyclethrin with various Synergists against Body Lice.**—*J. econ. Ent.* **49** no. 5 pp. 643–645, 6 refs. Menasha, Wis., 1956.

Laboratory tests were carried out with 15 synergists in combination with cyclethrin [*R.A.E.*, B **43** 56] against *Pediculus humanus humanus* L., in comparison with pyrethrins and allethrin alone and in combination with sulfoxide [1,2-methylenedioxy-4-(2-(octylsulphinyl)propyl)benzene] and cyclethrin alone as standards. The mixtures were tested as cloth impregnants in beakers [**34** 44–45] and retested at weekly intervals after application. A 1:10 ratio of toxicant to synergist was used in all cases. The α-propylpiperonyl, 4-(3,4-methylenedioxyphenyl)-sec-butyl and α-isopropylpiperonyl esters of chrysanthemic acid were the most effective synergists for cyclethrin, the mixtures containing them giving 100 per cent. kill for five weeks. The mixture with sulfoxide was among the least effective, giving 100 per cent. kill initially, and 95 per cent. after one week. Pyrethrins with sulfoxide were more effective than cyclethrin with any synergist.

Allethrin with sulfoxide was slightly less effective than cyclethrin with some of its better synergists. Neither cyclethrin, pyrethrins, nor allethrin showed appreciable toxicity without a synergist, and none of the synergists alone was toxic at the concentration used. Pyrethrins and allethrin were completely effective at a lower concentration than cyclethrin, when each was used in combination with sulfoxide.

In comparative tests of the lasting effectiveness on cloth patches of pyrophyllite powders containing cyclethrin, pyrethrins and allethrin with and without the addition of ten parts sulfoxide to one part toxicant, only pyrethrins caused any knockdown or mortality when used alone. When each was combined with sulfoxide, cyclethrin was slightly slower in knockdown than allethrin or pyrethrins, and cyclethrin and allethrin both gave effective mortality for a somewhat shorter time than pyrethrins.

HUNTER (P. E.). **Length of larval Period related to DDT-resistance in *Drosophila*.**—*J. econ. Ent.* **49** no. 5 pp. 671–675, 1 fig., 13 refs. Menasha, Wis., 1956.

In view of observations on a relationship between resistance to DDT and length of the larval stage in house-flies [*Musca domestica* L.] [*R.A.E.*, B **43** 190; but *cf.* also **39** 84; **42** 76], two strains of *Drosophila melanogaster* Mg., one with a short larval period (SL) and the other with a long larval period (LL), were obtained by selection from a stock normally susceptible to DDT and larvae of the selected strains and of an unselected control strain (CS) were assayed for DDT-resistance at five separate generations of selection, ranging from 29th to 53rd. There was a difference of some 18–20 hours in the duration of the larval period in the selected strains, with the control strain about half way between them.

The following is substantially the author's summary of the results. The slopes of the dosage-mortality regression lines varied from assay to assay but showed a consistent pattern with SL steepest, LL intermediate and CS shallowest. This relationship did not hold in one generation where CS had the steepest slope. The differences among strains in the slopes of the dosage-mortality regression lines were not significant in all cases. The LD50 value for SL was less than that for CS or LL in all generations tested.

When the data of the separate generations were pooled and treated as a single test, the dosage-mortality regression line for SL was significantly steeper than that for LL or CS. On the basis of the pooled data, SL showed a significantly lower LD50 value than LL or CS. No significant difference in the slope of the dosage-mortality regression lines or in LD50 values was found between LL and CS. Selection for longer larval period produced no significant change in DDT-resistance of LL over that of CS, but selection for short larval period resulted in increased susceptibility to DDT of SL as compared with the other two strains.

BROWN (B. E.) & BROWN (A. W. A.). **The Effects of insecticidal Poisoning on the Level of Cytochrome Oxidase in the American Cockroach.**—*J. econ. Ent.* **49** no. 5 pp. 675–679, 1 fig., 14 refs. Menasha, Wis., 1956.

As it had been shown that DDT and many other insecticides affect the cytochrome oxidase of tissue from *Periplaneta americana* (L.) [*R.A.E.*, B **43** 153], lethal doses of DDT, methoxy-DDT (methoxychlor), parathion, malathion and a thiocyanate (β-butoxy β′-thiocyanodiethyl ether) were injected as solutions in maize oil into the haemolymph of adult males of the cockroach 2–4 weeks after the final moult to ascertain whether they

had any *in vivo* effects on the enzyme. Death usually occurred within 24 hours or very soon after. For the first eight hours after injection of DDT, the cockroaches passed through the typical stages of DDT poisoning without any significant change occurring in the level of the cytochrome oxidase. The cytochrome-oxidase activity in the coxal muscles of cockroaches treated with each insecticide decreased slightly in 24 hours, but the decrease was not significant with parathion or methoxy-DDT, and only with the thiocyanate was it significantly greater than that in cockroaches killed electrically. Malathion and the thiocyanate caused post-mortem reductions 24–48 hours after injection, but the other insecticides did not. It is concluded that DDT does not affect the activity *in vivo* of the cytochrome oxidase of *P. americana*. The cause of the inhibition of cytochrome oxidase by DDT *in vitro* is discussed with reference to the literature, and it is concluded that non-specific adsorption is responsible. Cytochrome oxidase was shown to increase markedly in males of *P. americana* but not in females, after the final moult.

March (R. B.), Metcalf (R. L.), Fukuto (T. R.) & Gunther (F. A.). **Fate of P^{32}-labeled Malathion sprayed on Jersey Heifer Calves.**—*J. econ. Ent.* **49** no. 5 pp. 679–682, 1 fig., 7 refs. Menasha, Wis., 1956.

Two Jersey heifer calves were each treated twice at an interval of two weeks with one U.S. pint spray containing 0·5 per cent. ^{32}P-labelled malathion, and the fate of the malathion and its metabolites was studied after the second application. The malathion was rapidly absorbed, metabolised and eliminated in the urine; 96–99 per cent. of the radioactive material eliminated was in the form of water-soluble metabolites and degradation products [*cf. R.A.E.*, B **45** 76], and the amount of activity appearing in the urine was greatest in the first 24 hours, after which it gradually decreased. The two calves were killed one and two weeks after the second spraying, and residues in ten cuts of the meat and in tongue, brain, spinal cord, thymus, thyroid, pancreas, kidney, liver, heart, rumen, suet, bone, marrow and hide were determined radiometrically. Only water-soluble metabolites and degradation products were present in detectable quantities in the tissues, except in the hide, in which 2·7 per cent. of the labelled compounds recovered after two weeks was in the form of unchanged malathion and chloroform-soluble metabolites. Total residues in the meat cuts were low (0·05–0·15 parts per million) and indicated very uniform distribution throughout the animal. Somewhat higher values (0·15–0·18 p.p.m.) for the tongue were probably attributable to the heifers' habit of licking themselves. Higher residues (0·2–2 p.p.m.) were found in thymus, thyroid, pancreas, liver and bone, and indicated that phosphorus from the degraded compounds was being used in the normal metabolic activities of the animal. The largest amounts (3–18 p.p.m.) were found in the hide. Chemical analyses for malathion in tissues of the foreleg, hind leg and rump of the two heifers showed no detectable malathion (less than 0·2 p.p.m.).

Mitlin (N.). **Inhibition of Development in the House Fly by 3,4-Methylenedioxyphenyl Compounds.**—*J. econ. Ent.* **49** no. 5 pp. 683–684, 9 refs. Menasha, Wis., 1956.

As the addition of piperonyl butoxide to the culture medium was found to have a strong inhibitory action on the development of house-flies [*Musca domestica* L.] of both normal and insecticide-resistant strains [*R.A.E.*, B **44** 23], several other compounds containing the 3,4-methylenedioxyphenyl group, of which many have shown synergistic activity with pyrethrum, most

are relatively non-toxic to warm-blooded animals and many are inexpensive, were tested to determine whether they too could inhibit the development of the fly. Initial tests were carried out with concentrations of 0·25 and 1·125 per cent., and if development was completely inhibited, the concentration was reduced until a threshold value was found. The results are given in a table. Death occurred in the third larval instar or in the pupal stage. None of the compounds affected the viability of eggs laid by surviving flies. There did not appear to be any definite relationship between the ability of a compound to inhibit development and its activity as a synergist. Two of the best compounds were sulfoxide [1,2-methylenedioxy-4-(2-(octylsulphinyl)propyl)benzene] and sulfone [1,2-methylenedioxy-4-(2-(octylsulphonyl)propyl)benzene], and when these were further tested at concentrations of 0·0313, 0·0157, 0·0078 and 0·0039 per cent. by weight, the percentages of emergence of susceptible (and resistant) flies were 3 (13), 47 (27), 91 (48) and 100 (100) for sulfoxide and 2 (8), 26 (52), 56 (77) and 97 (83) for sulfone.

Owen (B. L.). **Life History of the Spiny Rat Mite under artificial Conditions.**—*J. econ. Ent.* **49** no. 5 pp. 702–703, 4 refs. Menasha, Wis., 1956.

A stock of *Laelaps* (*Echinolaelaps*) *echidninus* Berl. was cultured on a white rat in a sheet-metal box, and life-history studies were made by removing females with a bulb aspirator and isolating them and their offspring in glass tubes, which were 5 cm. long, had an outside diameter of 1 cm. and were closed at each end by a piece of bolting cloth pushed into the tube by a piece of rubber tubing 6 mm. long. The tubes were kept at a relative humidity of about 80 per cent. and a temperature of 30°C. [86°F.]. The mites were fed on cold human blood by a method already noticed [*R.A.E.*, B **43** 195], and tubes were changed daily. The mite is viviparous, and has four stages: hexapod larva, protonymph, deutonymph and adult. All stages feed except the larva. Larvae were removed to a separate tube as soon as they were noticed. They usually remained in one place until they moulted, but would move quite rapidly when touched. The average durations (and ranges of duration) of the various stages were 11·5 (10·5–12·5) hours for the larva, 6·5 (3·5–11) and 4·8 (3–8) days for the protonymph in two series of observations and 5·3 (3–9) days for the deutonymph. The reason for the difference in the duration of the protonymphal stage in the two series is not known. There was no difference between the series in the other stages. The nymphs of both stages fed within a few hours of ecdysis. Most of the females began to produce young 5–6 days after ecdysis. Some attacked their newborn larvae and sucked them dry, but efforts to induce them to eat their nymphs or small arthropods of other species were unsuccessful. Females could reproduce parthenogenetically, but mated readily if given the opportunity. Adult females lived 61–91 days, with an average of 78·7 days. Two males observed lived 57 and 76 days. Unfed protonymphs and deutonymphs lived 6–7 and 7–12 days, respectively, and protonymphs and deutonymphs allowed to feed once only lived 5–13 and 14–16 days. No moults occurred with only one feeding. Four adults not allowed to feed lived 7–8 days.

Hoffman (R. A.) & Monroe (R. E.). **Control of House Fly Larvae in Poultry Droppings.**—*J. econ. Ent.* **49** no. 5 pp. 704–705, 7 refs. Menasha, Wis., 1956.

When laying hens are kept in raised wire-floored pens, the breeding of *Musca domestica* L. in the accumulated droppings may become a serious

problem if the droppings do not dry quickly and particularly if they are kept moist by faulty watering devices or sprinkling systems. Under these conditions, the use of an effective larvicide would appear practical. Several insecticides were tested in 1955 on plots containing 24–30 sq. ft. manure 4–6 ins. deep under caged hens near Fresno, California. Emulsion sprays of malathion, Chlorthion [O,O-dimethyl O-3-chloro-4-nitrophenyl phosphorothioate], Am. Cyanamid 4124 [O,O-dimethyl O-2-chloro-4-nitrophenyl phosphorothioate], Diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate] and dieldrin and water solutions of Bayer L 13/59 [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate] were applied with a compressed air sprayer at 10–200 ml. per sq. ft. and at concentrations to give 10–1,500 mg. insecticide per sq. ft. Within the limits of 40–100 ml. per sq. ft., the volume of spray applied did not greatly affect the results, but smaller amounts did not give thorough coverage and larger ones, though possibly more effective, were inconvenient to apply. The results for the applications at 50 ml. per sq. ft. are given in a table. Diazinon gave 95, 100 and 100 per cent. kill in 48 hours at rates of 10, 25 and 50 mg. per sq. ft., and Bayer L 13/59 gave 100, 100 and 99 per cent. kill at these rates. Both gave complete kill in 24 hours at 100 mg. per sq. ft. or more. Dieldrin killed all first- and second-instar larvae at 500–1,500 mg. per sq. ft., but did not kill all third-instar larvae at even the highest rate, and gave no mortality at 100 mg. or less. Malathion gave 93–97 per cent. kill at 500–1,500 mg. per sq. ft., and Am. Cyanamid 4124 gave 95 per cent. kill at 1,500 mg. but much less at lower rates. Neither gave appreciable control at 100 mg. Chlorthion gave only 70 per cent. kill at the highest rate. Reinfestation usually occurred on the third or fourth day after effective treatment with 100 mg. toxicant or less, or on the fourth or fifth day in plots treated with larger amounts, except in the case of Diazinon, which usually kept plots free for 1–2 days longer.

Ringel (S. J.) & Gooden (E. L.). **Storage Tests of Water-dispersible Insecticide Powders at Temperatures from −50 to +55°C.**—*J. econ. Ent.* **49** no. 5 pp. 711–712. Menasha, Wis., 1956.

Water-dispersible powders containing DDT or dieldrin were stored at controlled temperatures of 55, 10, −12 and −50°C. [131, 50, 10·4 and −58°F.] and high and low humidities for a year, and similar powders containing DDT, dieldrin and γ BHC (lindane) in a hot and a cold climate in the field for rather longer, and they were then tested for dispersibility and particle size. It is concluded from the results that with water-dispersible powders of these insecticides formulated to standards for ordinary use, there are no serious storage hazards from rigorous climatic conditions except at high temperatures, and that at such temperatures high humidity is an additional hazard.

Rodriguez jr. (J. L.) & Riehl (L. A.). **Four Pesticides tested against the Fowl Tick infesting Turkeys in Feed Lots.**—*J. econ. Ent.* **49** no. 5 pp. 713–714, 3 refs. Menasha, Wis., 1956.

Sprays of malathion, Diazinon [O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate], Chlorobenzilate [ethyl 4,4′-dichlorobenzilate] and FW-293 [di(p-chlorophenyl)-trichloromethyl-carbinol], all prepared from emulsion concentrates and containing 1 per cent. actual toxicant were applied at high pressure to wooden feeding troughs for the control of *Argas persicus* (Oken) on turkeys in large range-type pens in California in September 1955. The turkeys roosted on the troughs at night,

and no ticks were found elsewhere in the pens. All feeding stuff was cleared from the troughs before they were treated, and the turkeys were kept away from the pens until the sprayed troughs were completely dry. Only as much food as would be consumed in a short time was put in the troughs for one week after treatment. Malathion and Diazinon gave complete control of the tick in 24 hours and for the observation period of 21 days following application. Chlorobenzilate and FW-293 reduced tick populations considerably by the fourth day but failed to eradicate the infestations. Turkeys from the pens treated with malathion and Diazinon were free from skin blemishes due to tick feeding when slaughtered for market.

Mitlin (N.) & Babers (F. H.). **The Action of Radiostrontium in the House Fly and the German Cockroach.**—*J. econ. Ent.* **49** no. 5 pp. 714–715, 2 refs. Menasha, Wis., 1956.

The authors investigated the effect of radiostrontium on adults of *Musca domestica* L. and *Blattella germanica* (L.), using $^{89}SrCl_2$ in HCl as the source. Its initial activity was 8·29 mc. per ml. For the experiments with house-flies, 5 ml. (41·45 mc.) was mixed into 5 gm. dried skimmed milk, and for those with the cockroach, 3·2 gm. meat-based dog biscuit was ground and impregnated with 10 μl., diluted with water for better dispersion, to give 0·083 mc. Newly emerged house-flies of an insecticide-susceptible strain were allowed to feed for 18 hours on the treated milk, after which they were separated into two lots, one of which was allowed to continue feeding on the treated milk while the other was fed on ordinary skimmed milk. The radioactivity of five flies of each sex from the second lot was determined daily for five days, at which time it levelled off. The biological half-life of the ingested strontium was estimated at 14 hours for the males and 16·8 hours for the females. Attempts to induce the flies to oviposit were begun three days after they emerged. Those that had fed continuously on the treated milk laid no eggs, but those that had fed on it for only 18 hours laid many. The average radioactivity of these eggs was 0·42 counts per egg per minute, and their viability was 15 per cent. as compared with a usual viability of about 95 per cent. for eggs of normal flies. Eggs were also obtained from flies that were fed on the treated milk for two weeks and then on untreated milk for three days; they had an average activity of 23·5 counts per egg per minute, and only 2 per cent. hatched.

Difficulty was experienced in inducing the cockroaches to feed on the impregnated food, probably because of its acidity. Only three out of five of each sex consumed enough in three days to show discernible radioactivity. These were then given a normal diet, and their radioactivity was determined periodically. The biological half-life of the ^{89}Sr was estimated to be 3·25 days after cessation of feeding for the males and 0·95 days for the females. No conclusion could be drawn as to whether the ^{89}Sr caused sterility. None of the females developed oothecae, but this might have been due to natural causes.

Richards (R.). **An emulsifiable Concentrate for Pyrethrum and similar Insecticides.**—*J. econ. Ent.* **49** no. 5 p. 719, 4 refs. Menasha, Wis., 1956.

The New Jersey mosquito larvicide, which is a coarse emulsion of oil containing pyrethrum extract [*R.A.E.*, B **23** 205], has been used by some workers in population studies of Tabanid larvae, which are driven to the surface when the emulsion soaks into the soil. It was thought that a finer emulsion with better dispersion of the pyrethrum might be more efficient.

Fine emulsions of kerosene solutions of toxaphene had been made with CTX-54 (a blend of nonionic and anionic surfactants), but as that emulsifier was not completely soluble in the kerosene alone, it seemed that the presence of the chlorinated-hydrocarbon insecticide must have contributed to its solubility. The effect of adding several chlorinated hydrocarbons to the pyrethrum-kerosene system was therefore investigated, and four chlorinated polyphenyls (Aroclor 1221, 1232, 1242 and 1248) were found to be the most satisfactory. Concentrates consisting of 5 per cent. of a 20 per cent. pyrethrum extract, 11 per cent. CTX-54, 55 per cent. of one of the Aroclors and 29 per cent. kerosene all gave complete spontaneous dispersion in cool hard or distilled water, and the resulting emulsions remained well dispersed for an observation period of 14 days. Emulsifiability was not affected by the addition of 10 per cent. piperonyl butoxide. Two special formulations were made for use in field studies of Tabanid larvae. One contained 1 per cent. (by weight) pyrethrins, 10 per cent. piperonyl butoxide, 11 per cent. CTX-54 and 33 per cent. Aroclor 1248 in deodorised kerosene, and the other was the same without piperonyl butoxide. D. W. Anthony found them helpful under certain conditions in studying Tabanids in Florida.

In another series of formulations, the concentration of pyrethrins was increased to 5 per cent., the amount of kerosene decreased and the proporportion of emulsifier and Aroclor maintained at the same level. Excellent emulsions resulted. Comparison of five formulations containing 25 per cent. of 20 per cent. pyrethrum extract, 10 per cent. emulsifier and different amounts of Aroclor showed that at least 30 per cent. Aroclor was needed to ensure a good emulsion. When a formulation containing 10 per cent. pyrethrins, 40 per cent. Aroclor 1221, 10 per cent. CTX-54 and 40 per cent. kerosene was diluted to form an emulsion containing 0·05 per cent. pyrethrins, the dispersion was spontaneous and stability good. In preliminary field tests, several formulations of pyrethrins, allethrin or cyclethrin were applied to test animals in 0·05 per cent. emulsions. The presence of an Aroclor had no visible adverse effects on dairy or beef cattle, and did not seem to increase or reduce the effectiveness of the insecticides.

Bailey (S. W.) & McCabe (J. B.). **A Controller for a Light Source.**—*Bull. ent. Res.* **48** pt. 3 pp. 463–465, 1 pl., 1 fig. London, 1957.

The following is almost entirely the authors' summary. An instrument is described that will brighten and dim a light source and control the periods for which it operates. The periods of brightening and dimming and the period of full illumination are both adjustable, the former from 0·5 to 2 hours and the latter from 8 to 16 hours. The instrument has been used successfully for studying the effects of changing light intensity and photoperiod on the activity and development of insects.

Hocking (B.). **Louse Control through Textile Fibre Size.**—*Bull. ent. Res.* **48** pt. 3 pp. 507–514, 3 pls., 1 graph, 15 refs. London, 1957.

The following is substantially the author's summary. The possibility of controlling the human body louse (*Pediculus humanus humanus* L.) through the development of clothing that is inimical to it on physical rather than chemical grounds was investigated. Claw size in lice of various species was shown to be related to diameter of host hair. The grip force of *P. h. humanus* on fabrics made of fibres of various diameters and compositions, some spun and some unspun, and of various weaves largely dictated by

availability, was measured with an apparatus of which the essential parts were a torsion balance and a kymograph motor. The force was found to be a maximum at fibre-diameters approximating that of human hair. The ability of the lice to grab hold of a fabric when dropped on to an inclined surface of it was also measured and was found to vary similarly with fibre-diameter but to a smaller degree than did grip force. The number of eggs laid on fabrics where no choice was offered was also found to vary with fibre-diameter in a similar manner. While this physical method of louse control is not promising for immediate practical application, it has possibilities that may be enhanced by developments in textile technology.

McDonald (W. A.). **A Calliphorid Host of *Thyridanthrax abruptus* (Lw.) in Nigeria (Diptera, Bombyliidae).**—*Bull. ent. Res.* **48** pt. 3 p. 533, 4 refs. London, 1957.

During January and February 1957, pupae of the Calliphorid, *Rhyncomyia pictifacies* Big., were collected from the stream-bed sand of dry-season breeding sites of *Glossina palpalis* (R.-D.) and *G. morsitans submorsitans* Newst. at three places in Northern Nigeria; 33 of these pupae were found at Rahama, in Bauchi Province, and eight adults of *Thyridanthrax abruptus* (Lw.) emerged from them. This finding extends the known distribution and host range of the Bombyliid [*cf. R.A.E.*, B **17** 212; **45** 18].

Davies (L.). **A Study of the Age of Females of *Simulium ornatum* Mg. (Diptera) attracted to Cattle.**—*Bull. ent. Res.* **48** pt. 3 pp. 535–552, 6 figs., 16 refs. London, 1957.

The observations described were carried out on females of *Simulium ornatum* Mg. collected on cattle near Durham or reared from pupae found in a stream beside the pasture [*cf. R.A.E.*, B **45** 127–128] and the following is substantially the author's summary of them. Females of *S. ornatum* were found to contain abundant fat-body on emergence from the pupa. Unengorged individuals fed on sucrose solution in the laboratory at 16–18°C. [60·8–64·4°F.] or 22–23°C. [71·6–73·4°F.] showed depletion of the fat-body until little remained after 14 days. Females engorged on cattle in the field and kept in the laboratory at 16–18°C. became gravid in 4–5 days, when virtually no fat-body remained.

Females taken on cattle in the field in 1952–54 were divided into two main categories on dissection. One comprised those with visible fat-body in the anterior abdominal segments, only 0·06 per cent. of which contained relict ripe eggs. The other comprised those with no fat-body in the corresponding region, and 16·5 per cent. of them contained relict ripe eggs, indicating a previous complete gonotrophic cycle. Evidence is given that the two categories approximately corresponded to young flies that had not obtained a blood-meal and to old flies that had. There was no evidence that flies rebuilt the fat-body after depletion. Fresh blood in the mid-gut was seen more often in old flies than in young ones at certain times. This suggests that the former bit more readily or more quickly than the latter. The average age of the Simuliids caught varied inversely with their abundance, except towards autumn, when length of adult life may have increased. The proportion of old females among the total number landing on a cow varied during the day and often increased significantly in late evening, at the same time as total landing activity increased. Failure of the proportion of old females to increase in late evening on two days was possibly caused by the curtailment of activity owing to rapid fall of air

temperature, so that the phase characterised by abundance of old flies was omitted. On another evening, the activity of old females was apparently reduced owing to the effect of wind being greater on them than on young ones. On days in mid-season, the number of old flies landing on cattle usually remained constant, while large fluctuations occurred in the numbers of young flies, except in late evening when the numbers of old and young flies landing tended to rise together. In autumn, the numbers of old and young flies fluctuated together throughout the day. In the case of a disease transmitted by the bite of *S. ornatum*, a susceptible host would have been exposed to a greater number of potentially infective bites in late evening than in the middle of the day in mid-season and to a far greater number of such bites in early autumn than in mid-season.

GILLIES (M. T.). **Age-groups and the Biting Cycle in** *Anopheles gambiae*. **A preliminary Investigation.**—*Bull. ent. Res.* **48** pt. 3 pp. 553–559, 13 refs. London, 1957.

The results obtained by various workers who have studied the biting activity of *Anopheles gambiae* Giles are compared in a table. There was some apparent discrepancy between the relative sizes of mid- and late-night catches, but this was probably partly due to the experimental technique. Comparison between results obtained for periods during which the mosquitos were caught in the act of biting and those for periods during which they entered dwellings indicated some pause inside the house before the host is attacked. An investigation designed to test the hypothesis that certain features of the biting cycle could be explained in terms of the predominant activity of a particular age-group was carried out in April–June 1953 at Tengeni, near the Tanganyika coast, where malaria is holoendemic and sporozoite rates in *A. gambiae* are high. A technique for classifying females of *A. gambiae* into three age-groups, pre-gravid, gravid and non-infective, and gravid and infective [*R.A.E.*, B **43** 71–72] was used to establish the proportions of the age-groups among females that entered experimental huts during each of three periods into which the night was divided and were found in the morning to be freshly fed. The three periods were from 6.30 p.m. (5–17 mins. after sunset) to 10 p.m., 10 p.m. to 2 a.m. and 2 to 5.30 a.m. The only access to the huts for mosquitos was through shutters that were opened at the beginning of a given experimental period and closed at the end of it. The mosquitos could feed on people sleeping in the huts at any time after they flew in; they were collected in the morning and those not freshly fed were discarded. Of total catches of 1,091 pre-gravid females and (in brackets) 1,937 gravid females, the percentages that entered the huts during the first, second and third periods of the night were 20·2 (14·9), 42 (50·5) and 37·8 (34·6). The percentages fertilised (containing sperm) among pre-gravid females that entered during the three periods were 20·4, 24·1 and 27·9 and the sporozoite rates among gravid ones were 3·6, 2·7 and 1·3 per cent. It is not considered that the main features of the biting cycle in *A. gambiae* can be explained in terms of the differential activity of the three age-groups.

HUGHES (J. C.). **Olfactory Stimulation of Tsetse Flies and Blowflies.**—*Bull. ent. Res.* **48** pt. 3 pp. 561–579, 5 graphs, 25 refs. London, 1957.

The following is the author's summary. An apparatus for exposing insects to known concentrations of vapours from odorous liquids is described;

it was used in a laboratory in England to test adult tsetse flies, *Glossina palpalis* (R.-D.) and *G. morsitans* Westw., obtained from Africa as pupae, and the blowfly, *Phormia terraenovae* R.-D. There is a definite pattern of behaviour of the flies in olfactory stimulants, in the final phase of which they are excited to fly. The number of seconds for which a fly is in flight gives a measure of its activation by the vapour. The method gives results comparable with those obtained with a standard choice-chamber technique and has considerable practical advantages for work with tsetse flies. The effects of concentrations of vapour, period of exposure, condition of the flies and external conditions on the response of tsetse flies to vapours were studied.

The response of *G. morsitans* and *P. terraenovae* to a selection of aliphatic acids, alcohols, esters and amines was determined, using a standardised procedure. There is a marked similarity between the two species in the concentrations of vapours required to activate them. The standard molar concentration, defined as the concentration of vapour required to raise the activity of the flies to a standard level of ten times that in pure air, was calculated for each compound tested from the regression of activity on concentration. Threshold concentrations (the highest concentrations that failed to raise fly-activity) were also calculated from the regression equations.

A multiple regression analysis was used to relate the standard molar concentrations to five physical properties of the compounds, namely vapour pressure, water solubility, molecular volume, dipole moment and dielectric constant. A similar analysis was carried out relating median repellent concentrations (those repelling 50 per cent. of the flies in a standard choice chamber) to the same five physical properties, using data previously obtained by V. G. Dethier for the blowfly, *Phormia regina* (Mg.). The results suggest that a compound having low vapour pressure, low dielectric constant and, possibly, high dipole moment, is likely to be a good olfactory stimulant. A mechanism is suggested for the olfactory stimulation of flies, depending upon the orientation of polar molecules in the membranes of the olfactory sensilla.

Possible practical applications of olfactory stimulants for tsetse flies are discussed.

Hughes (J. C.). **Olfactory Stimulation of *Glossina palpalis* (R.-D.) by Combustion Products from Petrol Engines.**—*Bull. ent. Res.* **48** pt. 3 pp. 581–583, 3 refs. London, 1957.

In view of an observation that *Glossina swynnertoni* Aust. was attracted by the exhaust fumes from a lorry [*R.A.E.*, B **26** 74], the effects of exhaust gases and distillates of sump oil from old motor cars on the activity of *G. palpalis* (R.-D.) were briefly investigated by the method noticed in the preceding abstract. The exhaust gases had no effect on the flies, and the threshold and standard stimulating concentrations of vapour of distillates from sump oil decreased as the boiling point of the fractions increased. The experiment indicated that compounds that stimulate tsetse flies at very low concentrations are unlikely to be present in quantity in the combustion products from motor-car engines.

MacLeod (J.) & Donnelly (J.). **Individual and Group Marking Methods for Fly-population Studies.**—*Bull. ent. Res.* **48** pt. 3 pp. 585–592, 4 refs. London, 1957.

The following is almost entirely from the authors' summary. Four different methods used by them for marking blowflies are described in

detail. The methods are individual marking with paints, mass powdering with dyes, making the flies radioactive by adding ^{32}P to the drinking water or, more reliably, a sugar solution in the cages in which they are confined, and a combination of the last two. A fifth method, in which a fluorescent dust is spread over the soil in which the pupae are developing so that the emerging flies become labelled with it, is briefly described. The circumstances affecting the choice of method are outlined.

BAR-ZEEV [formerly WOLFINSOHN] (M.). **The Effect of extreme Temperatures on different Stages of** *Aëdes aegypti* **(L.).**—*Bull. ent. Res.* **48** pt. 3 pp. 593–599, 9 refs. London, 1957.

The following is partly based on the author's summary. Earlier investigations on the effects of extreme temperatures on different stages of *Aëdes aegypti* (L.) [*R.A.E.*, B **8** 156; **22** 29; **37** 99; **38** 175] were supplemented by studies of eggs, larvae and pupae in water, and of eggs and adult females in air at various relative humidities. Larvae of the same instar in groups of 100, and young pupae (less than half an hour old) and old pupae (at least 36 hours old), both in groups of 25, were kept for various periods at low temperatures (0·5, 4, 8 and 12°C. [32·9, 39·2, 46·4 and 53·6°F.]) in incubators, or at high temperatures (35, 40, 41, 43 and 45°C. [95, 104, 105·8, 109·4 and 113°F.]) in glass cylinders closed at their lower ends by cloth filters and inserted into water baths, and then transferred to water at 28°C. [82·4°F.]. Mortality was determined from the numbers of larvae that survived for 24 hours and the numbers of pupae that gave rise to adults. Eggs in batches of 1,000 were similarly treated, after which periods of 24 hours in water at 28°C. with yeast added were alternated with drying periods of 24 hours, and mortality was determined on the numbers of larvae that hatched and survived to the third or fourth instar. Adult females (four days old) were exposed in groups of 50 for various periods in jars over the appropriate solutions to give a complete range of relative humidities and kept at low, medium and high temperatures. Eggs in batches of 1,000 were subjected to the same treatments. The adults were kept at 28°C. and 60 per cent. relative humidity before treatment and for 24 hours afterwards, and mortality was then determined. Mortality of eggs was determined after alternate 24-hour periods of wetting and drying at 28°C. The results of all the experiments were expressed as the exposure times needed to give 50 per cent. mortality (T50), calculated from the observed data.

At 0·5, 4 and 8°C., T50's in hours were 394, 446 and 523 for eggs in water, 16·6, 22·8 and 83·1 for larvae (means of the value for the four instars), 31, 60·3 and 217·5 for young pupae and 12·1, 27·4 and 74·8 for old pupae. At 41, 43 and 45°C., the T50's in minutes were 624·6, 117·4 and 27·6 for eggs in water, 190·3, 64·9 and 9·7 for larvae, 376·5, 64·7 and 12·3 for young pupae, and 264·4, 39·5 and 8·1 for old pupae. The various larval instars differed little in resistance to extreme temperatures. The resistance of adults to very low and to very high temperatures (0·5°C. and 40°C. or over) was not affected by humidity, the temperatures alone being lethal. T50's at 41, 43 and 45°C. were 32·8, 16·9 and 6·8 minutes. At the other temperatures examined, resistance increased with relative humidity, which was the more important factor. T50's at 100 per cent. relative humidity and 0·5, 4, 8, 12, 28, 35 and 40°C. were 9·7, 48·7, 32, 25, 104·7, 48·3 and 0·6 hours. The fact that the T50 was less at 12° than at 8° and at 8° than at 4°C. was probably due to greater activity at the higher temperature. Activity was, furthermore, much greater at 12° than at 28°C. In experiments at the seven temperatures up to 40°C. in air at various humidities,

the T50's for eggs in dry air were 2·8 and 1·4 days at 35 and 40°C., but hatching was normal at all other temperatures and humidities used, for periods up to 32 days, except at 28°C. and 100 per cent. relative humidity when there was a poor hatch owing to the development of fungi.

ISHERWOOD (F.). **The Resting Sites of *Glossina swynnertoni* Aust. in the wet Season.**—*Bull. ent. Res.* **48** pt. 3 pp. 601–606, 1 pl., 1 graph, 15 refs. London, 1957.

Catches of *Glossina swynnertoni* Aust. made on fly-rounds at Shinyanga, Tanganyika, contain a very low proportion of females, and nearly all females taken are hungry. As little is known of the fly's habits when it is inactive, a search was made for resting flies to discover where inactive periods are spent. Previous recorded observations on resting places of *Glossina* are briefly reviewed. They show that the resting sites chosen differ from species to species, and even within a species. Differences within species probably reflect seasonal changes in climate and vegetation. In an area of hard-pan at Shinyanga during the short rainy season in 1956, *G. swynnertoni* was found to rest on the underside of branches of small trees, with the long axis of the body parallel with that of the branch and the head pointing up the slope, if any. The resting flies were easily caught in glass tubes measuring 6 × 1 inch. In catches of resting (and active) flies, females formed 28 (7·5) per cent. of the total and 25 (4·5) per cent. of the non-teneral flies, teneral females formed 20 (62) per cent. of all females, and females with blood formed 59 (6·3) per cent. of non-teneral females. Wilson successfully controlled a form of *G. palpalis* (R.-D.) by applying insecticides to vegetation in only part of its habitat [*R.A.E.*, B **42** 25–26]. Similarly, control of *G. swynnertoni* by spraying resting sites within hard-pan areas is envisaged.

MCMAHON (J. P.). **Notes on the *Simulium neavei* Group of Simuliidae with particular Reference to *S. nyasalandicum* and *S. woodi*.**—*Bull. ent. Res.* **48** pt. 3 pp. 607–617, 7 figs., 16 refs. London, 1957.

The following is virtually the author's summary. Simuliid larvae and pupae found in phoretic association with the fresh-water crab, *Potamonautes niloticus* (M.-Edw.), in Kenya rivers far from the haunts of *Simulium neavei* Roub. [*cf. R.A.E.*, B **40** 5] gave rise to adults that proved to be *S. nyasalandicum* De Meillon, a member of the *neavei* group. Very similar larvae, and pupae that differed slightly from those of *S. nyasalandicum*, were found in the exhalant passages from the gill chamber of the crab. These yielded adults of *S. woodi* De Meillon, and no other species was found in this particular situation; nor were examples of *S. woodi* found on the external surface of the crab. As many as three larvae were found in one passage and, in another crab, a fully grown larva and pupa caused complete obstruction of the passage on one side. Apart from the security enjoyed by the larva in the sheltered position, it is thought probable that the association is essentially a commensal one.

The morphological differences between the adults of the three members of the *neavei* group (*S. neavei*, *S. nyasalandicum* and *S. woodi*) are given and figured. The larvae, pupae and cocoons of *S. nyasalandicum* and *S. woodi* are also described, and morphological differences are figured.

Notes are given on the distribution and habits of the two latter species, for neither of which is man the preferred host. In fact, over a period of

some 12 years, not a single example of *S. woodi* has been captured on the wing during the course of many hundreds of catches made in Kenya under a variety of conditions.

BURNETT (G. F.). **Trials of Residual Insecticides against Anophelines in African-type Huts.**—*Bull. ent. Res.* **48** pt. 3 pp. 631–668, 9 graphs, 19 refs. London, 1957.

The following is substantially the author's summary. Tests of insecticide deposits against *Anopheles gambiae* Giles and *A. funestus* Giles in native-type huts fitted with exit traps [*cf. R.A.E.*, B **41** 152–154] were continued at Taveta, Kenya, from November 1951 until August 1955. The term active or absorbent is used for a substance that removes insecticide in the vapour phase from the external surface and adsorbs it on the internal surfaces: it is not used for capillary absorption.

DDT wettable powder at over 2·5 gm. DDT per sq. metre in a hut with plaster of absorbent mud gave, for eight months, kills of over 50 per cent. of the female Anophelines that entered. BHC wettable powder at 0·24 gm. γ isomer per sq. metre gave kills of over 50 per cent. for nine months or more in huts with absorbent walls. On non-absorbent walls, the kill fell rapidly during the third month and was negligible by the fifth. The insecticide persisted in walls of active material after the roof of inactive materials had become relatively innocuous. Wettable powders combining DDT and BHC, applied at rates giving 0·08–0·26 gm. γ BHC per sq. metre, were not effective unless the deposit of DDT was at least 2·1 gm. For an equivalent cost, BHC alone was more effective than the mixture on active walls and dieldrin on inactive ones. BHC in urea-formaldehyde resin at 2·5 gm. γ BHC per sq. metre was persistent, but the persistence was not commensurate with the cost of the material and difficulty of applying it. The insecticide persisted longest on mud surfaces, presumably because it is absorbed from the skin of resin and later released as vapour. Absorption would render a non-volatile insecticide permanently innocuous.

Aldrin wettable powder was found considerably less persistent than BHC on absorbent walls.

When dieldrin as wettable powder was applied in the range 0·3–0·5 gm. per sq. metre, it was found that absorptive substrates reduced the persistence of the treatment, even though the wall was the only part of the hut that was absorptive. For example, 0·42 gm. per sq. metre on an entirely inactive substrate gave kills in excess of 50 per cent. for 44 weeks, whereas 0·49 gm. in a hut with active walls did so for only 24 weeks. In a hut with walls of equal parts active soil and inactive sand, 0·5 gm. per sq. metre gave kills in excess of 50 per cent. for 40 weeks. In performance, it approached the inactive hut more closely than the active one, even allowing for the lower rate in the inactive hut. The low dose of 0·3 gm. per sq. metre in another hut plastered with a soil-and-sand mixture was equal in effectiveness to the 0·49 gm. in the hut with active plaster. These rates approached and exceeded those believed at the time to have been used in earlier trials with dieldrin, which had been very much more successful. In tests in which the applied dosage was measured, very high kills for over a year were obtained only in a hut with mixed plaster, treated at the rate of 0·83 gm. per sq. metre. This treatment gave excellent results for over two years. A similar rate in a hut with walls of pure mud of only moderate activity broke down within a year, but the trial was unsatisfactory in several ways and the recorded persistence is probably a minimum. Consideration of the persistence of repeated treatments makes it seem likely that 0·8 gm. dieldrin per sq. metre as 25 per cent. wettable powder would be highly

effective for over nine months in a hut plastered with active soil, and would give kills of over 65 per cent. for a full year. In a hut lined with banana leaf, a dieldrin deposit of about 0·43 gm. per sq. metre obtained from a commercial emulsifiable concentrate was found rather less persistent than 0·42 gm. per sq. metre from a commercial wettable powder.

Second applications of dieldrin in huts with mud or mud-and-sand walls were much more persistent than the first treatment. This is here termed the augmenting effect. Economy can be made by reducing either the application rate or the frequency of treatments. On impervious materials, there is no such effect. The experiment with repeated applications of BHC was spoilt by ants, which removed the dead mosquitos from the floor of the hut. DDT would be expected to behave like dieldrin, but no trial was made. Treatment of part only of a hut (walls or roof) was less efficient than treatment of the whole hut. Insecticide that falls on a concrete or even a mud floor has a strong but short-lived effect, exerted as airborne dust.

It was shown that the fumigant-type effect of dieldrin [*cf. loc. cit.*] is exerted by particles too large to pass filter paper, but BHC has true vapour action. Particles of dieldrin contaminated clean surfaces introduced into a heavily treated hut as much as 15 months after spraying, rendering them lethal. Smoke from wood fires quite rapidly rendered dieldrin ineffective, particularly reducing the particulate effect. BHC was not adversely affected. A pronounced effect of season on mortalities was found, which appears to be related to atmospheric humidity, the effect of rain falling in otherwise dry periods being particularly marked. This may change the results of tests for fumigant or particulate action from zero to complete kills.

It is concluded that DDT, BHC and dieldrin all have their uses in control of Anophelines, and treatment schedules are suggested for them. It is noted that the highly-divided dieldrin formulations prepared according to specifications of the World Health Organisation [**45** 137] may be found less persistent on active surfaces than the crude preparations available for these trials.

Bruce-Chwatt (L. J.) & Service (M. W.). **An aberrant Form of *Anopheles gambiae* Giles from southern Nigeria.**—*Nature* **179** no. 4565 p. 873, 3 refs. London, 1957.

No morphological character is known by which the adults of *Anopheles gambiae gambiae* Giles and the salt-water coastal form, *A. g. melas* Theo., can be separated with certainty [*R.A.E.*, B **33** 33; **34** 138–9; **41** 115], but constant differences have been believed to exist between the eggs [**34** 5] and between the larval pectens [**33** 32]. However, the eggs in 68 of 251 egg batches laid by blood-fed females of *A. gambiae* collected at Abeokuta and Ibadan, 60 and 100 miles inland, respectively, from the coast of Nigeria, were morphologically characteristic of *melas*, whereas fourth-instar larvae reared from these eggs were physiologically *gambiae*, as they showed no resistance to salinity exceeding 12·5 gm. sodium chloride per litre when transferred from fresh water to saline solutions of various concentrations and left in them for 24 hours. No intermediate eggs had been found. The average length of the atypical eggs was greater than that of eggs of either *gambiae* or *melas*. The pectens of the larvae from them were typical of *gambiae*. A colony from these eggs was established, and the F_1 eggs were found to resemble the original ones. It is concluded that, at least in some parts of West Africa, *gambiae* and *melas* cannot be reliably separated by the characters of the eggs alone.

Iyengar (R.). **Développement de** *Wuchereria bancrofti* **(Cobbold) et de** *Wuchereria malayi* **(Brug).**—*Ann. Parasit. hum. comp.* **31** no. 1–2 pp. 99–138; no. 3 pp. 266–287, 43 figs., 3½ pp. refs. Paris, 1956.

The characters by which the microfilariae of *Wuchereria bancrofti* and *W. malayi* may be distinguished from one another are described, and full accounts are given of the development of the larvae of the former in *Culex pipiens fatigans* Wied. and of the latter in *Mansonia annulifera* Theo. The course of larval development was almost the same in the two species.

Iyengar (M. O. T.). **Developmental Stages of Filariae in Mosquitoes.**—*Tech. Pap. S. Pacif. Comm.* no. 104, iii + 11 pp., 11 pls., 15 refs., multigraph. Noumea, 1957.

In pursuance of a recommendation of a conference on filariasis in the area of the South Pacific Commission [*R.A.E.*, B **44** 181], photomicrographs are given of the developmental stages in the mosquito of larvae of *Dirofilaria immitis* and the nocturnal and non-periodic forms of *Wuchereria bancrofti*. They are supplemented by notes, illustrated by drawings, on morphological details of both microfilariae and larvae that are of importance in the differentiation of *D. immitis*, *W. bancrofti* and *W. malayi*, though the last is not known to be endemic in the area. The microfilariae are included as they are sometimes found in undigested blood in the midgut. The techniques recommended for studying the larvae and microfilariae are described, and notes are also given on certain artefacts, parasites and pseudoparasites that may be mistaken for the larvae. The name *W. pacifica* has been proposed for the non-periodic form of *W. bancrofti* on the basis of biological characteristics [**42** 84], but the two forms are here grouped together as the microfilariae and larval phases present no morphological differences.

Cushing (E. C.). **History of Entomology in World War II.**—*Publ. Smithson. Instn* no. 4294, 8¼ × 5½ ins., vi + 117 pp., 9 pls., 2 figs., refs. Washington, D. C., 1957.

A popular survey is given of the extent to which insects and mites (mainly Trombiculids) that transmit diseases or cause serious annoyance affected American troops in war areas during the second world war, the development of methods of controlling them and the part played by entomologists in basic research and in the control of pests of agricultural crops and essential products during the war years.

Blanc (M.) & d'Aubenton (F.). **Observations préliminaires relatives à une campagne de lutte contre l'onchocercose. Action de quelques insecticides sur les poissons.**—*Méd. trop.* **16** no. 1 pp. 93–100, 11 refs. Marseilles, 1956.

There is an important focus of onchocercosis caused by *Onchocerca volvulus* and transmitted by Simuliids (principally *Simulium damnosum* Theo.) in the southern part of Haute-Volta in French West Africa. Control is urgently required and could most easily be effected by destroying the vectors. R. Taufflieb, working in French Equatorial Africa, found that γ BHC gave good control of Simuliid larvae, but caused heavy mortality among fish [*R.A.E.*, B **45** 49–50]. Loss of fish would be a very serious matter in Haute-Volta, as they constitute the only source of animal protein for many

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people. Great care would therefore be necessary in choosing the time to treat rivers and the insecticide to use, and in measuring the flow of water. The best time to apply insecticides is in the dry season when access is easier, the volume of water involved smaller, and fish are not breeding. Accurate and frequent measurement of the rate of flow is necessary because correct dosage depends on this. A method is described of measuring flow by timing the passage of a floating object over a measured length of the stream and calculating the volume of water passing in a given time from this and the area of cross-section (product of width and average depth of the stream). Greater accuracy is obtained by including a coefficient of friction, which depends on the ratio of the area of cross-section to the sum of the width and twice the average depth of the stream. The coefficients for various ratios in metres in the case of a stream with an earth bed are given in a table; they range from 0·593 to 0·813 for ratios ranging from 0·15 to 9·14.

As a preliminary to determining the best product to use and finding a dosage adequate for control and safe for fish, experiments were made in France with kinds of fish closely related to those in the affected area. The fish were exposed to the treated water for 30 minutes and then returned to their aquaria. BHC at 1 part γ isomer per million, the lowest concentration thought to be adequate for control, caused some mortality among them, and their sensitivity increased with repeated doses. DDT, on the other hand, appeared to be harmless at 7 p.p.m. and caused only very slight symptoms at 8 p.p.m. Further work in the area itself is needed to determine whether some such dose would give adequate control of Simuliids and prove sufficiently innocuous to the fish.

Wilson (C.). **Combating Onchocerciasis with little Expense.**—*W. Afr. med. J.* (N.S.) **5** no. 4 pp. 162–166. Ibadan, 1956.

Onchocercosis [caused by *Onchocerca volvulus*] is a serious problem in an area some 35 miles long and 10–15 miles wide in the eastern part of the Victoria Division of the southern Cameroons, where the vector is *Simulium damnosum* Theo. The area consists of plantations or thick bush and scrub, and many of the streams in which the Simuliids breed are very inaccessible. Because of this and the lack of transport and skilled staff, the regular, frequent and simultaneous treatment of the streams necessary to reduce the population to a negligible level could not be effected by the usual method of pouring graduated doses of insecticidal fluid into the streams. Instead, sawdust balls impregnated with a 20 per cent. solution of DDT in oil at eight balls per pint and wrapped in absorbent paper were distributed to local health authorities and plantation managers, with instructions to throw a specified number into each stream in the area for which they were responsible at the highest possible point on specified dates. Treatment every Saturday throughout the dry season (January–April) was specified, instead of the more desirable treatment every 5–6 days, because the instruction was more likely to be complied with. Treated streams were examined as often as possible where they crossed the main road, and when fourth-instar larvae were found, the dosage was increased. By the end of the treatment period, it was exceptional to find larvae, and adults had decreased enormously. However, examination of a large number of streams in the eight weeks after treatment ended showed breeding to be persisting in a few. Though eradication had not been expected, the results were less good than was hoped, probably because of failure to detect all the breeding streams, inadequate duration of the treatment season in streams in which the original dosage had been inadequate, and the abnormality of the 1956

dry season. In this year, the small dry season, which usually follows a small wet season in late March and April and is characterised by a few heavy showers causing flushing, failed completely, and the small wet season continued, keeping the streams at a uniform level. Several weeks later, larvae could be found in practically every suitable stream. The procedure was to be repeated in the following dry season.

CRISP (G.). *Simulium* **and Onchocerciasis in the Northern Territories of the Gold Coast.**—10 × 6½ ins., xvi + 171 pp., frontis., 52 figs., 5 maps (3 fldg.), 4½ pp. refs. London, Brit. Emp. Soc. Blind; H. K. Lewis & Co., Ltd., 1956. Price £2 17*s.* 6*d.*

This is the report of the work of a team led by the author, which spent three years (1952–1955) investigating the distribution and habits of *Simulium damnosum* Theo. in the Northern Territories of the Gold Coast, where it is the vector of *Onchocerca volvulus*, the parasite responsible for onchocercosis and consequently for a high rate of blindness among the population. The object of the investigation was to find a way of controlling it, and particular attention was given to its method of surviving the dry season. The adults were trapped by three methods. These were covering them with a tube as they bit, sweeping vegetation with nets, and putting emergence cages over pupae in streams.

The following is based on the author's summary. The physical and climatic features of the Northern Territories are described. The rivers are of four types: those that flow throughout the year, of which the Black Volta is the only true example; those that flow for most of the year, such as the Nasia and the White Volta in its lower reaches; those that are dry or in pools for most of the year, which constitute the largest group; and the small streams that flow only at the height of the rains. The seasonal distribution of *S. damnosum* is considered in representative streams of each type. In 1953 and 1954, adults were taken during the dry season when no river was in flow. Many more were taken in 1954, when the climate was much more humid and showers arrived unusually early. The geographical distribution of the Simuliid in the different parts of the Northern Territories is given, and instances are cited of the formation of temporary local conditions favourable to breeding by the topography of the country through which the river flows, so that colonies develop for a short time each year.

Various aspects of the biology of the adults are discussed. The females will bite anywhere out of doors, even 600 ft. above a breeding place, and will also attack inside brightly lighted houses during the day. Only two were taken at night. The hours of maximum density at most seasons were 8–10 a.m. and 4–6 p.m., but a few individuals were taken at other times during the rains in September. Biting is influenced by meteorological conditions, increasing particularly with falling pressure, and catches were highest on days following showers. The flies were seen attacking cattle, donkeys, goats, sheep, dogs and birds. Animals were bitten on the belly, where the hair is thinner, and man chiefly on the legs, even in trees. Black skins were more attractive than white. About 2 per cent. of several hundred newly emerged adults bit men in a large cage over the river. The flies rest on vegetation but are not found there at certain times of the day and night. None was smoked out from holes among stones of a bridge or from clefts in the rocks of the river bed, although a cloud of females was noticed flying round such situations. Three were smoked out of holes in shady bowers, where there was much more overhanging vegetation. The humidities in such places were higher and the temperatures lower than in the open. The flies occurred in large numbers five miles from a river and

can carry infection that distance. Densities at seven miles are also large. Males and females emerged in the large cage in about equal numbers.

Studies on the early stages were carried out during the dry season and the rains. Oviposition is described in some detail. The eggs take about 36 hours to hatch at various temperatures. The larval stage lasts some 10–13 days at 25°C. (77°F.), and the pupal stage some 4–5 days. Not all individuals in a brood mature at the same time; there is often a difference of two or three days. Larvae were abundant only in the swifter parts of streams, particularly in cascades. They were attached to rocks, plants, tins, etc. None was ever found on mayfly nymphs or crabs. In the Black Volta, breeding is at its maximum in the dry season, when larvae occur in the shallow river on rocks and twigs. When the water rises, breeding takes place on the vegetation at the side of the bank, but is spasmodic and reduced. Larvae are usually concentrated within six inches of the surface of the water, and few are found more than 18 inches down. In the rains, larvae left stranded by a sudden fall in level could survive out of water for at least a day. In the dry season, they died after exposure to the sun for 30 minutes, but could survive from the late afternoon until the following morning. Many larvae become dislodged and float along the river. Small larvae do not occur in rivers when the water is gritty. The pH of the rivers varied from 6·7 to 7·3, and did not appear to limit distribution. There was no breeding in streams with a high water temperature, probably owing to reduced oxygen content and increase of algae, which make the supports slimy.

Rates of infection of *S. damnosum* with *Onchocerca* vary from day to day and appear to decrease in the dry season. The overall rates of 11·1 per cent. at the Red Volta and 13·1 per cent. at Nasia are lower than those recorded in the Sudan and in northern Nigeria. Four local species of *Culicoides* were investigated as possible hosts. They did not ingest microfilariae with the blood-meal, and no natural infections were found in them.

The incidence of *Onchocerca* in human communities in relation to exposure to *Simulium* is discussed. The facts appear to explain quite well the distribution and incidence of onchocercosis at some distance from breeding places. Often there is a hidden focus, and changing conditions due to deposition of silt or erosion may alter the known foci. The flight-range of infected Simuliids is considerable. There is movement of the people, and the incubation period is variable. Microfilariae were taken up with the blood-meal by 60 per cent. of females of *S. damnosum* taken on cattle, but the presence of infection in cattle in areas where *S. damnosum* does not exist seems to indicate that it may not be the vector or the only vector of cattle *Onchocerca* in the Northern Territories. The way in which *S. damnosum* may survive the dry season in the savannah lands when the rivers are reduced to pools is discussed at some length. The evidence suggests that it does so in the adult stage.

An experiment on control was initiated at the beginning of the rains in 1954. Stretches of the Kanyanbia and Sisili rivers were treated at intervals of four days from 20th July to 12th August with 10 per cent. DDT in fuel oil according to the method described by Hocking [*R.A.E.*, B **39** 162], and breeding was prevented for 24 days, but recolonisation from small streams was rapid. The experiment showed that the small streams cannot be neglected in an eradication scheme. Adults are taken over many areas in the Northern Territories, and the species cannot be eradicated in isolated areas because there is no natural barrier. However, local control can be exercised. Measures taken against Simuliids in other countries are discussed, and plans are given for a control scheme based on the division of the worst endemic area in the Northern Territories into seven regions for treatment of rivers with DDT in fuel oil.

Gahan (J. B.) & Mulhern (T. D.). **Field Studies with Water-soluble Insecticides for the Control of Mosquito Larvae in California Pastures.** —*Mosq. News* **15** no. 3 pp. 139–143, 1 fig., 2 refs. Albany, N. Y., 1955.

Tests were made in central California in 1955 to evaluate the effectiveness of water solutions of Bayer L 13/59 [dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate] and Shell OS 2046 [dimethyl 2-methoxycarbonyl-1-methylvinyl phosphate] for the control of mosquito larvae in irrigated pastures. The fields are flooded every 10–14 days with water from wells or large irrigation ditches, and if there is no provision for disposal of surplus, some parts remain covered for more than a week, allowing very large populations of mosquitos (about 80–95 per cent. *Aëdes nigromaculis* (Ludl.)) to develop. An automatic device [see next abstract] was used to introduce the chemical into the water as it entered the fields. The concentration dispensed from it varied with the amount of water to be treated and the concentration to be obtained in it. Shell OS 2046, at a concentration of 1 part per million in the treated water, gave 100 per cent. control, and Bayer L 13/59 at 3, 1 and 0·1 p.p.m. gave 100, 99·9–100 and 74 per cent., respectively. Tests with *Aëdes* larvae in water samples from the plots showed that the treated water lost none of its toxicity while flowing half a mile through the fields. Samples taken two days after application of Bayer L 13/59 were completely effective against second- and third-instar *Aëdes* larvae, but others collected on the eighth day were ineffective. There was no control in plots treated with Bayer L 13/59 after they had been dried and reflooded with untreated water. This lack of residual toxicity may be due to the alkaline soil in the fields, as phosphorus insecticides have been found to be unstable in an alkaline medium.

Gahan (J. B.), Labrecque (G. C.) & Bowen (C. V.). **An Applicator for adding Chemicals to flowing Water at Uniform Rates.**—*Mosq. News* **15** no. 3 pp. 143–147, 2 figs., 3 refs. Albany, N. Y., 1955.

The following is the authors' summary. An apparatus that automatically applies chemicals to moving water at a uniform rate is described. It furnishes a simple means of maintaining a constant hydrostatic head on the liquid column in a gravity feed device. The applicator consists of a well, made of metal pipe, from which the liquid gradually escapes through a sprayer nozzle in the bottom. Near the top of the well is a lateral opening that connects to an airtight reservoir. When the liquid level in the well is high enough to cover the lateral opening, the air supply to the reservoir is cut off, a vacuum forms, and the flow ceases. As soon as sufficient liquid escapes from the bottom of the well to uncover part of the lateral opening, air enters the reservoir and displaces sufficient liquid to seal the opening again. A 55-gallon metal drum with a lacquered interior is a convenient reservoir. The apparatus was developed primarily for applying insecticides to irrigation water, but also has other uses.

Mathis (W.), Elmore (C.) & Schoof (H. F.). **Further Studies on the chemical Control of Rice Field Mosquitoes in Mississippi.**—*Mosq. News* **15** no. 3 pp. 148–153, 1 fig., 4 refs. Albany, N. Y., 1955.

In continuation of studies with dieldrin against larvae of rice-field mosquitos in Mississippi [*R.A.E.*, B **43** 7], the effect of the treatment on the adult population was investigated in 1954 in a large-scale test involving 2,900 acres of rice-fields sufficiently removed from peripheral untreated rice

to minimise the danger of infiltration. All fields in the test area received a preflood application of 0·5 lb. dieldrin per acre in emulsified solution, sprayed from an aircraft between 27th April and 21st June. Adult populations were assessed by the use of 40 light-traps operated twice weekly. Over 1·6 million mosquitos were collected during the season, of which *Psorophora confinnis* (Lynch Arrib.) and *P. discolor* (Coq.) represented 96–98 per cent. and most of the others were *Anopheles quadrimaculatus* Say. Control of *P. confinnis* was excellent until the end of June, after which it was not considered satisfactory. Control of *P. discolor* and *A. quadrimaculatus* was unsatisfactory throughout. Dosages as high as 2 lb. per acre were shown to be ineffective against breeding by *Psorophora* in tests on small plots, and a postflood treatment at 0·1 lb. per acre was also unsatisfactory. Bentonite pellets containing 5 per cent. dieldrin broadcast at 0·1 and 0·2 lb. dieldrin per acre over fields previously treated with 0·5 lb. dieldrin in emulsified solution gave 87 and 78 per cent. control of *Psorophora* larvae, but this was not considered adequate in view of the large populations remaining. The failure of freshly applied dieldrin against the larvae suggested the occurrence of resistance to it. To evaluate this, pupae of *P. confinnis* were collected from treated and untreated fields in August, and females that emerged from them were exposed for 45 minutes in cylinders lined with paper treated with solutions containing 0·25 per cent. dieldrin or 1 per cent. DDT, and then kept for 24 hours in untreated cages. The dieldrin killed 17 and 87 per cent., respectively, of the females from treated and untreated fields, whereas the former were as susceptible to DDT as the latter. It is concluded that *P. confinnis* had acquired a marked resistance to dieldrin in the treated area, presumably because of predisposition through exposure to chemicals (including endrin, aldrin and dieldrin) used for crop dusting.

Lieux (D. B.) & Mulrennan (J. A.). **Mayfly Control.**—*Mosq. News* **15** no. 3 p. 156, 1 ref. Albany, N. Y., 1955.

During 1953, mayflies, examples of which were identified as *Hexagenia munda orlando* Traver, emerged in such numbers from a 200-acre lake in Florida that some residents considered moving from the district. Sampling in January 1954 with a dredge indicated a population of 125,452,800 mayfly nymphs in the lake. On 13th April, a suspension of BHC from a wettable powder was dispersed at 0·24 lb. γ isomer per acre over the lake by gravity flow from a drum mounted in a small motor-boat. Sampling 23 days later failed to reveal the presence of any living nymphs, and periodical inquiry produced no reports of the presence of adults during 1954. There was no apparent damage to fish or other aquatic wildlife.

Edmunds (L. R.). **Notes on the Biology and seasonal Abundance of the larval Stages of *Culex tarsalis* Coquillett in irrigated Areas of Scotts Bluff County, Nebraska (Diptera: Culicidae).**—*Mosq. News* **15** no. 3 pp. 157–160, 2 figs., 6 refs. Albany, N. Y., 1955.

A study of the breeding places of *Culex tarsalis* Coq. in an irrigated area in western Nebraska was made from May to the end of October 1953 with a view to elucidating the relation between irrigation and production of this mosquito. Nearly all the larvae found were in permanent or semi-permanent seepage areas and surface pools, most of which were man-made and related directly to irrigation. Associated species were predominantly *Culiseta inornata* (Will.) in permanent or semi-permanent seepage areas and *Aëdes dorsalis* (Mg.), *A. vexans* (Mg.) and *A. nigromaculis* (Ludl.) in temporary water. Beds of *Chara* were frequent where production of *Culex*

tarsalis was high. Permanent control of *C. tarsalis* in the area studied would involve the elimination of seepage areas and residual pools on irrigated pastures. The first fourth-instar larvae were found on 25th May and the last fourth-instar larvae and pupae on 29th October. The larval population reached its peak during the week ending 11th July. Egg rafts contained 143–331 eggs, with an average of 244. The rate of development in permanent seepage areas was studied by isolating egg rafts in metal cylinders, 20 inches in diameter, with the lower end buried in the bottom mud. Hatching generally occurred 1–3 days after an egg raft was isolated and the period from hatching to adult emergence ranged from 14 days at an average air temperature of 78·5°F. to 31 days at 63·4°F.

Hedeen (R. A.). **The Discovery of a Member of the *Anopheles maculipennis* Complex breeding in Treeholes in France.**—*Mosq. News* **15** no. 3 pp. 161–162, 3 refs. Albany, N. Y., 1955.

Three fourth-instar larvae of *Anopheles maculipennis* Mg. were collected from a rot hole in a plane tree (*Platanus acerifolia*) in western France on 1st and 2nd July 1954 and ten more from a rot hole in an ash tree (*Fraxinus angustifolia*) in the same general area on 31st October. One female was reared from the first batch and two from the second, but as no eggs were laid, the variety involved could not be determined. The pH of the water in both holes was 7·2. This is thought to be the first record of the finding of a member of the *maculipennis* complex breeding in tree-holes in Europe.

Komp (W. H. W.). **The Oviposition of *Haemagogus equinus* in Nature (Diptera, Culicidae).**—*Mosq. News* **15** no. 3 pp. 163–164, 2 refs. Albany, N. Y., 1955.

No observation on oviposition by any species of *Haemagogus* in nature appears to have been recorded, but the author, while searching for larvae in the Panama Canal Zone in June 1945, saw a female ovipositing on short green moss surrounding a shallow hole in the trunk of a mango tree. The moss was kept moist by capillarity from the water beneath. After six eggs had been deposited at intervals of about one minute, the female was caught and the eggs were collected. The female did not oviposit in captivity. Three of the eggs, attached to the mossy bark, were immediately put in water from a bamboo section in which other *Haemagogus* larvae had been developing. These failed to hatch. The other three, attached to the moss, were kept for a little more than 72 hours in a humid atmosphere and then immersed in water from the bamboo section. These hatched, and the larvae, fed on brewers' yeast, produced one adult male and two females. From examination of the terminalia of the male, the species concerned was identified as *H. equinus* Theo.

Komp (W. H. W.). **The Breeding of *Haemagogus argyromeris* D. and L. in saline Water (Diptera, Culicidae).**—*Mosq. News* **15** no. 3 pp. 179–180, 5 refs. Albany, N. Y., 1955.

Haemagogus argyromeris Dyar & Ludl., which is widespread and common in the Panama Canal Zone and adjacent parts of the Republic of Panama, probably has a wider range of breeding places than any other species of *Haemagogus* [*cf. R.A.E.*, B **41** 79] but no member of the genus was hitherto known to tolerate sodium chloride. The author here records finding fourth-instar larvae late in June and July and again in October in several

years in saline water in rock holes on the Pacific shores of the Republic of Panama. Adults were reared from them, and the males identified as *H. argyromeris*. The holes are well above the high-water line and are dry during the dry season (January–April). Spray is blown on-shore during the high spring tides, and some of it reaches the holes and evaporates. The holes fill with water after the onset of the rains in May. Samples of the water in which the larvae were found contained up to 0·9 per cent. sodium chloride. The larvae had very short anal gills, an adaptation to water of high salt content.

Chapman (H. C.). **Tests with granulated and systemic Insecticides against *Mansonia* Larvae.**—*Mosq. News* **15** no. 4 pp. 204–206, 1 ref. Albany, N. Y., 1955.

The following is mainly from the author's summary. The results are given of laboratory and field tests of insecticides against larvae of *Mansonia* in Florida in 1954–55. The predominant species in all tests was *M. indubitans* D. & S., and the plants to which the larvae were attached were *Pistia stratiotes*. Of 15 insecticides tested in the laboratory on granular bentonite, only six gave more than 90 per cent. mortality at 0·25 parts per million. Of these, parathion and EPN [O-ethyl O-p-nitrophenyl phenylphosphonothioate], gave 100 per cent. kill at 0·025 and 0·1 p.p.m., respectively, and endrin, DDVP [dimethyl 2,2-dichlorovinyl phosphate], γ BHC (lindane) and dieldrin gave 100, 100, 97 and 95 per cent. kill at 0·25 p.p.m. DDVP, however, became progressively less effective than γ BHC and dieldrin as the concentrations were reduced to 0·1 and 0·05 p.p.m. When these materials as 1 per cent. granules were tested in the field, EPN at 0·25 and 0·1 lb. per acre gave excellent control after 1, 14 and 21 days, and dieldrin and endrin at 0·1 lb. gave poor control after 1 day but good control after 14 and 21. DDVP, γ BHC and parathion were not satisfactory at 0·1 lb. Field tests were also made with schradan and Systox [diethyl 2-(ethylthio)ethyl phosphorothioate] applied in 1 per cent. emulsions with a hand atomiser at 0·25, 0·1 and 0·05 lb. per acre. Neither was effective initially, and no systemic action was noted with either after one or three weeks.

Fox (J. W.) & Fox (R. M.). **Maxillary Index and biological Races in *Anopheles gambiae* Giles.**—*Mosq. News* **15** no. 4 pp. 207–214, 4 graphs, 12 refs. Albany, N. Y., 1955.

The maxillary indices of 621 females of *Anopheles gambiae* Giles from Marshall Territory, Liberia, ranged from 11 to 19·5. The mean index was 14·6 and analysis of the data showed that dispersion of the frequencies lay almost exactly within the limits of a normal curve, and thus indicated a pure population. The mosquitos comprised 310 collected in and near dwellings, 149 collected over a swamp, and 162 from the eighth and ninth generations of a laboratory colony, and these groups showed mean maxillary indices of 14·6, 14·6 and 14·8, respectively. These findings are contrary to expectancy under the two-race theories advanced by Campbell [*R.A.E.*, B **40** 41] and by Holstein [**41** 116] and lead the authors to review the works concerned.

It is concluded that each of the two theories has a basic fallacy in that the paucidentate and the multidentate races in question were sympatric, and, as there was no evidence of sexual isolation, could not maintain genetic distinctiveness. Both Campbell and Holstein appear to have dealt with homogeneous but variable populations. A platykurtic distributional curve does not necessarily indicate the existence of two biological populations.

Use of maxillary index to define the paucidentate and multidentate populations as races (subspecies?) violates the law of ecological incompatibility in that the overlapping range of maxillary indices is much too large. Moreover, Gillies has found that the index varies according to whether or not the larvae develop under crowded conditions [**43** 124, 125]. As is to be expected of a widely distributed, adaptable insect, females of *A. gambiae* evidently incline to deposit eggs in the first available water found after the eggs mature and will take blood-meals from the most convenient donor (man or animal), with a preference for man when a choice is available.

Thurman jr. (D. C.) & Thurman (E. B.). **Report of the initial Operation of a Mosquito Light Trap in northern Thailand.**—*Mosq. News* **15** no. 4 pp. 218–224, 3 graphs, 8 refs. Albany, N. Y., 1955.

After one year of extended house-spraying with DDT in the municipality of Chiengmai, northern Siam, a light-trap of the New Jersey type was operated on 282 nights during the year beginning on 16th April 1952 and nearly 29,000 mosquitos caught in it were identified. They belonged to 11 genera and 66 species or subspecies, a list of which is given, and included one genus and 11 species of other genera not previously recorded from Siam. Species of *Culex* and *Anopheles* constituted 78 and 18 per cent. of the total collection, respectively.

The 13 members of the genus *Anopheles* taken were all recorded as natural or experimental vectors of malaria in a recent monograph [*R.A.E.*, B **41** 191], and three of them, *A. hyrcanus sinensis* Wied., *A. h. nigerrimus* Giles and *A. barbirostris* Wulp, have been reported to be vectors of filariasis [*Wuchereria malayi*] in southern Siam [**45** 26], but *A. minimus* Theo., stated to be the only Anopheline in which sporozoites have been found in Siam and the only known vector of malaria in the northern part of the country, was not taken in the trap or in house inspections, nor was it represented in collections of larvae, though it had been abundant in the Chiengmai area before the DDT spraying was begun in 1951. The more abundant species of *Culex* included *C. tritaeniorhynchus* Giles and *C. gelidus* Theo., from both of which the virus of Japanese B encephalitis has recently been recovered in Malaya, and *C. pipiens pipiens* L. and *C. p. fatigans* Wied. (*C. quinquefasciatus*, auct.), which, like *C. tritaeniorhynchus*, are known to be able to transmit it [*cf.* **40** 162]. Of the other mosquitos trapped, *Aëdes vexans* (Mg.) has been reported as a vector of eastern equine encephalitis in the United States, *A. albopictus* (Skuse) and *Armigeres obturbans* (Wlk.), as laboratory vectors of western equine and St. Louis encephalitis, *A. obturbans* as a vector of filariasis [*W. bancrofti*] in Ceylon and India, and *Mansonia indiana* Edw., *M. annulifera* (Theo.) and *M. uniformis* (Theo.), as vectors of filariasis [*W. malayi*] in southern Siam [**45** 26].

Mosquito populations increased with the progress of the rainy season (June–August) but declined during the September floods. Anophelines increased to a second and higher peak in November before declining sharply again, but other mosquitos continued to decrease in numbers throughout the dry-cold season (November–January).

Beckel (W. E.). **Oviposition Site Preference of *Aedes* Mosquitoes (Culicidae) in the Laboratory.**—*Mosq. News* **15** no. 4 pp. 224–228, 6 refs. Albany, N. Y., 1955.

The following is based on the author's summary. In tests of preferences for oviposition sites by species of *Aëdes* that occur in northern Canada and *A.*

aegypti (L.), black and white and rough and smooth surfaces were offered to *A. hexodontus* Dyar and *A. aegypti*, and open water and moist white filter paper to *A. campestris* D. & K. Black was conclusively chosen in preference to white and rough to smooth by both species. *A. campestris* chose open water more often than moist filter paper. *A. communis* (Deg.), with which no controlled experiment was made, was noted to choose damp dark areas in the laboratory cages for oviposition in preference to moist white cloth. *A. hexodontus* showed a temperature preference for oviposition at 73·97 ± 0·422°F. in 1953 and 74·18 ± 0·229°F. in 1954. It appears that this species could lay over a wide range of temperatures in the field, as evidenced by the wide range of temperatures over which the eggs were laid in the laboratory, but a preference might be shown for the temperatures mentioned.

Komp (W. H. W.). **Notes on Mosquitoes from an Area of endemic Yellow Fever in Colombia (Diptera, Culicidae).**—*Proc. ent. Soc. Wash.* **58** no. 1 pp. 37–42, 25 refs. Washington, D. C., 1956.

Misidentifications of some of the mosquitos recorded in 1935 near Restrepo, Colombia, in an area of endemic yellow fever [*R.A.E.*, B **24** 205] are corrected, and notes are given on others and on a few species subsequently found in the area. Laboratory transmission of yellow fever by *Psorophora ferox* (Humb.) has not been confirmed [**26** 65] and it is no longer considered a vector in nature. *Haemagogus janthinomys* Dyar has been shown to be a synonym of *H. spegazzinii* Brèthes [**37** 26], and subsequent dissection of the terminalia of males reared from larvae collected at Restrepo showed them to be *spegazzinii falco* Kumm, Osorno & Boshell. However, L. E. Rozeboom later obtained males of *spegazzinii* some 12 miles from Restrepo. Larvae collected from tree-holes by the author in 1944 produced males of *H. regalis* D. & K. [**44** 80], and M. Bates then informed him that he suspected that about 2 per cent. of all adults of *Haemagogus* collected in the region were *regalis*. The species identified as *Aëdes dominicii* (Rangel & Romero Sierra) is now stated to be *A. whitmorei* Dunn.

Srivastava (H. M. L.). **Anopheline Fauna of Uttar Pradesh. Part I. Vectors of Malaria.**—*Indian J. Ent.* **17** (1955) pt. 3 pp. 363–372, 5 figs., 16 refs. New Delhi, 1956. **Part II. Non-vectors of Malaria.**—*Op. cit.* **18** (1956) pt. 2 pp. 177–184, 8 figs., 2 refs. 1956. **Part III. Key for the Identification of the Species.**—*T. c.* pt. 3 pp. 256–258, 1 ref. 1957.

Uttar Pradesh, which covers an area of over 112,500 square miles, has about 16 species of *Anopheles* of which four, *A. culicifacies* Giles, *A. fluviatilis* James, *A. minimus* Theo. and *A. stephensi* List., have been reported to be vectors of malaria. Notes are given in the first part of this paper on the breeding places, feeding habits and importance as a malaria vector of each of these four species and a key for separating them. The eight natural physiographical divisions into which the State can be divided are also described, with notes on the vectors and their breeding places in each.

A. culicifacies has been found breeding chiefly in fresh collections of rain water or flood water, including borrow-pits. In the districts of scanty rainfall, however, it breeds only in the summer, when the larvae occur in residual pools in river-beds. Collections of adults in Lucknow in 1954 showed that it rests with equal readiness in dwellings and in cattle sheds. It is the chief rural vector of malaria in the plains of Uttar Pradesh and has recently been shown to be a vector in urban areas also. *A. minimus*

has been found in the dark huts of labourers, mainly on mud walls up to a height of four feet, and never in cattle sheds. It was the chief vector in the foot-hills area for a long time, but is now dying out with the clearing of jungle, and such females as were taken and dissected were negative for malaria parasites. Recent investigations have shown that *A. fluviatilis* is now the chief vector in the foot-hills; it was mainly anthropophilous, and gland infections were found in 10 per cent. of the females examined in 1951. *A. stephensi*, which feeds equally readily on man and cattle and rests indifferently in dwellings and cattle-sheds at Lucknow, was found infected there in 1954 and is stated to be important in urban areas throughout the State.

Briefer notes on the breeding places, adult habits and local distribution in Uttar Pradesh of the 12 species that are not vectors of malaria there are given in the second part of the paper, and a key to the adults of all the 16 species in the third.

Mattingly (P. F.). **The Culicine Mosquitoes of the Indomalayan Area. Part I. Genus *Ficalbia* Theobald.**—61 pp., 23 figs., 62 refs. London, Brit. Mus. (Nat. Hist.), 1957. Price 15*s*.

This is the first part of a revision of the Culicini of the Indomalayan area, including Tenasserim, peninsular Siam, Malaya, the Sunda Islands, Borneo, Celebes and the Philippines. Nine species of *Ficalbia* are recognised from the area, of which one is new and another is represented by two varieties, and they include members of all the four subgenera (*Ficalbia*, *Mimomyia*, *Etorleptiomyia* and *Ravenalites*) into which the author divides the genus. *Ravenalites* was erected as a genus for three new species of mosquitos from Madagascar by Doucet in 1950, and he designates one of them (*R. roubaudi*) as its type in a foreword to the present revision.

Webbe (G.). **Dieldrin in granulated Form as a Mosquito Larvicide. I. Results of Trials carried out in artificial Earth Pools.**—*Ann. trop. Med. Parasit.* **49** no. 4 pp. 353–355, 3 refs. Liverpool, 1955. **II. Results of Trials carried out in natural Pools.**—*T. c.* pp. 356–361, 3 refs.

Mosquito larvicides are probably best applied in granulated form where heavy vegetative cover makes oil solutions unsuitable. The experiments of Christie & Webbe have shown that dieldrin is very toxic to larvae of *Anopheles gambiae* Giles [*R.A.E.*, B **44** 84], and it gave good control of rice-field mosquitos when applied in pellets in the United States [**40** 153–154]. The first of these papers contains an account of experiments in Tanganyika in which Christie's method [**44** 6] was used to determine the minimum lethal dose of pellets containing 1 per cent. dieldrin for fourth-instar larvae of *A. gambiae* in artificially prepared earth pools [**44** 11]. Different dosages of the pellets (expressed as weight per acre) were scattered over the water by hand, and all the larvae were killed in 48 hours with dosages of 10 oz. or more. A dosage of 5 oz. killed about 97 per cent. in bare pools and 96 per cent. in pools into which vegetation had been introduced, indicating that this was almost the minimum lethal dosage and that the presence of vegetation does not inhibit the activity of the larvicide.

Field tests on the effect of the pellets on mosquito larvae in six natural ponds are described in the second paper. They were scattered by hand from the edge as widely as possible over the surface of the water at 10 oz. per acre. Eight weekly treatments were made, beginning in December, the middle of the dry season. The numbers of larvae dropped considerably after the first treatment, and the second and third eliminated all Anopheline larvae and all larvae of other mosquitos. The ponds that did not dry out

before they became infested again remained free from mosquito larvae until four weeks after the final treatment and from Anopheline larvae for a further fortnight. Other water insects virtually disappeared from the ponds after the third application of the pellets, but tadpoles, frogs and crabs were apparently unaffected. No observations were made on fish. The failure of the first application of the pellets to give 100 per cent. kill in the ponds could be explained by the fact that they were much deeper than the artificial pools and suggests that the dosage is not adequately expressed in terms of weight per acre.

Duke (B. O. L.). **Studies on the Biting Habits of *Chrysops*. III. The Effect of Groups of Persons, stationary and moving, on the Biting Density of *Chrysops silacea* at Ground Level in the Rain-forest at Kumba, British Cameroons.**—*Ann. trop. Med. Parasit.* **49** no. 4 pp. 362–367, 1 graph, 8 refs. Liverpool, 1955. **IV. The Dispersal of *Chrysops silacea* over cleared Areas from the Rain-forest at Kumba, British Cameroons.**—*T. c.* pp. 368–375, 3 figs., 6 refs.

Further observations on the biting habits of *Chrysops silacea* Aust. at Kumba [*cf. R.A.E.*, B **45** 82, etc.] are described in these papers. Those forming the subject of the first were carried out in May 1954 in the rain-forest. They showed that more flies are caught by groups of men working together at ground level than by one man working alone, and that the biting density (number of flies caught per man-hour) during a whole day on the forest floor is higher for each member of a group (0·38 for a group of eight and 0·48 for a group of 16) than for an isolated man (0·25). Catches by a group were not low in the early morning as are those made by a single man, but resembled rather catches made by one man at ground level with a fire or in the canopy without one [*cf.* **45** 83]. It is suggested, therefore, that the flies are attracted down from the forest canopy by a group of persons. When groups of men moved intermittently through the forest, imitating as closely as possible the activity of a roving troop of drills (*Mandrillus leucophaeus*) to determine whether drills, which may constitute a reservoir of *Loa* [**44** 119], are likely to be exposed to substantial biting during the day at ground level, they were subjected over the whole day to a slightly lower biting density (0·24 for eight or 0·33 for 16) than the corresponding stationary groups. The rates were low (0·15 and 0·16, respectively) during periods of movement, and high (0·47 and 0·64) during the intervening short periods of rest, which probably indicates that the flies were following the moving groups and biting mainly when the host was stationary. It thus appears that troops of drills are exposed to considerable biting by *C. silacea*, but the frequency with which the fly actually feeds is probably influenced by a number of factors, including the animal's watchfulness and agility.

Observations made in October and November 1954 on the dispersal of *C. silacea* over cleared areas in the forest are described in the second paper. The following is substantially the author's summary. It is shown that the biting density in the presence of a wood fire in clearings bordered by rain-forest where the fly breeds diminishes in a logarithmic manner as the distance between catching-station and forest increases. In a cleared area planted with rubber saplings 10–12 ft. high, the biting density fell to one-tenth of the forest value at 530 yards from the forest, with 95 per cent. confidence limits of 222 and 1,326 yards. In an area of total clearance planted with rubber saplings 1½–2 ft. high, the biting density fell to one-tenth of the forest value at 100 yards, with 95 per cent. confidence limits of 36 and 171 yards. It is suggested that the dispersal of the flies from the forest breeding-sites is effected in a series of short flights and depends on

the available intervening shelter. The dispersal of flies infected with *Loa loa*, and the possible use of ruthless barrier clearings as a control measure, are discussed.

Willett (K. C.). **A special Method for the Dissection of** *Glossina*.—*Ann. trop. Med. Parasit.* **49** no. 4 pp. 376–383, 4 figs., 2 refs. Liverpool. 1955.

The following is taken from the author's summary. A method is described for the dissection of *Glossina*, in which complete exposure of the abdominal and thoracic organs is obtained with the minimum of disturbance. It in no way supersedes well-known earlier methods, but is applicable where they are not. It can be used in the examination of dead tsetse-flies for trypanosome infections, and by its use living trypanosomes have often been found in flies believed to have been dead for as long as 16–20 hours. Simplified methods are also described for use in the dissection of dead tsetse-flies for trypanosome infections, one for the examination of abdominal contents only, and one for the examination of abdominal contents plus thoracic gut structures and salivary-gland ducts.

Shute (P. G.) & Maryon (M.). **Transmission of** *Plasmodium malariae* **by Laboratory-bred** *Anopheles maculipennis* **var.** *atroparvus* **Meigen.**—*Ann. trop. Med. Parasit.* **49** no. 4 pp. 451–454, 7 refs. Liverpool, 1955.

Plasmodium malariae, which is much rarer than *P. vivax* or *P. falciparum* and is always associated with one or other of them in areas in which it is endemic, is characterised by slow and scanty production of gametocytes. It was undoubtedly once endemic in parts of northern Europe in which the vector was almost certainly *Anopheles maculipennis* var. *atroparvus* van Thiel, but only one record of its experimental transmission by this Anopheline [*R.A.E.*, B **23** 229] was known to the authors, who had themselves repeatedly failed to obtain it [*cf.* **42** 12]. In 1954, however, working with an English strain of *atroparvus* bred in the laboratory and a Nigerian strain of *P. malariae*, they were successful in obtaining gland infections and effecting transmission. Five out of 72 stomachs dissected and eight out of 45 glands contained oocysts and sporozoites, respectively, and a patient bitten by females of the infected batch six times over a period of 12 days developed parasitaemia and fever within the usual incubation period.

True relapses of infection with *P. malariae* are reported in two people, 32 and 12 years, respectively, after infection. It is pointed out that, in view of the demonstration that relapses can occur after so long, control of malaria by incomplete eradication of vectors from a locality should always be accompanied by drug treatment of potential relapsing cases, as otherwise a return of high mosquito density might be accompanied by a return of *P. malariae* without the introduction of fresh carriers.

Nicholas (W. L.), Kershaw (W. E.) & Duke (B. O. L.). **Studies on the Epidemiology of Filariasis in West Africa, with special Reference to the British Cameroons and the Niger Delta. VII. Further Records of the Distribution of** *Culicoides* **spp., with a Note on the taxonomic Status of** *C. austeni*.—*Ann. trop. Med. Parasit.* **49** no. 4 pp. 455–460, 1 map, 16 refs. Liverpool, 1955.

This paper is the seventh of a series [*R.A.E.*, B **44** 179, etc.] in the fourth of which [**43** 43] the distribution of *Dipetalonema* (*Acanthocheilonema*) *perstans* in the British Cameroons was discussed in relation to that

of species of *Culicoides*. One of the chief of these was referred to as *C. austeni* C., I. & M., but a re-examination of specimens in the British Museum, including the two type series, has led the authors to conclude that *C. austeni* is a synonym of *C. milnei* Aust. Specimens collected in West Africa agree in every respect with Fiedler's redescription of *C. milnei* [**40** 193].

The relation to filariasis of the species of *Culicoides* that commonly bite man in the British Cameroons is at present ill-defined. It is considered to be proved that *C. milnei* is an intermediate host of *D. perstans* [**42** 103], but it has also been shown [**44** 10] that *C. grahamii* Aust. is an intermediate host of *D.* (*A.*) *streptocerca*, which is common in man. Consequently, it is difficult to interpret epidemiological data based on dissection of naturally infected flies, since a fly might be infected with either species or even acquire both from the same man. Moreover, chimpanzees are infected with *D. streptocerca* and with a filaria resembling *D. perstans*, and it is not known whether species of *Culicoides* can acquire infection from them, a point of critical importance, since the rates of infection in wild-caught flies is usually extremely low. The possibility that *D. perstans* has vectors other than *Culicoides* should not be overlooked [*cf.* **41** 99], but a species of *Culicoides* that is extremely numerous could be effective in transmission despite a very small incidence of infection in it.

Records are given of recent collections of *Culicoides* from Nigeria and the British Cameroons, representing an extension of the survey recorded in the third paper of this series [**42** 168]. They reinforce the earlier conclusion that *C. grahamii* and *C. milnei* are common throughout the rain-forests of the British Cameroons and southern Nigeria. *C. milnei* was also found to be present in parts of northern Nigeria, where *D. perstans* is locally a common parasite of man and the country is very different from the rain-forest. It showed the same nocturnal biting habits there as elsewhere. *C. inornatipennis* C., I. & M. and *C. nigeriae* I. & M., the other species taken as adults, seemed to be confined to the rain-forest and drier grasslands, respectively. Both were taken in the British Cameroons and *C. nigeriae* in northern Nigeria also. The record of *C. inornatipennis* from savannah with relict forest [**42** 168] was found to be based on a misidentification, the species in question being *C. nigeriae*.

Further records are given of the breeding sites of several species of *Culicoides* in the Kumba area. They lend support to the suggestion [**42** 168] that, although *C. milnei*, *C. grahamii*, *C. inornatipennis* and *C. fulvithorax* (Aust.) readily breed in rotting stems of banana and plantain in the British Cameroons, alternative breeding sites also exist in damp soil containing decaying vegetable matter. It is noteworthy that no bananas or plantains were growing in the places in northern Nigeria in which *C. milnei* was collected.

Reiss-Gutfreund (R. J.). **Isolement de souches de *Rickettsia prowazeki* à partir du sang des animaux domestiques d'Éthiopie et de leurs tiques.** —*Bull. Soc. Path. exot.* **48** (1955) no. 5 pp. 602–606. Paris, 1956.

The results are given of attempts made in Ethiopia to isolate *Rickettsia prowazekii* from the blood of 19 domestic animals (goats, sheep and cattle) and from 20 batches of *Amblyomma variegatum* (F.), six of *A. lepidum* Dön., 18 of *Hyalomma rufipes* Koch, 16 of *Rhipicephalus pulchellus* (Gerst.), 14 of *R. simus* Koch, nine of *R. evertsi evertsi* Neum., and nine of *Argas persicus* (Oken), taken from various domestic animals and poultry. Each batch comprised 2–10 ticks. One strain was isolated from a goat, two from sheep, two from batches of *A. variegatum* found attached to cattle,

and four from batches of *H. rufipes* found engorging on cattle and camels. The strains were identified by their pathogenicity for laboratory animals, lice [*Pediculus humanus humanus* L.] and embryonated hens' eggs and by serological tests, and also by comparison of their pathogenicity for sheep and lambs with that of classic strains of *R. prowazekii*. When fed on infected rabbits, *A. variegatum* and *A. lepidum* readily acquired infection with a classic strain and also with the strains isolated from the domestic animals and some of those from ticks. The results support the hypothesis that domestic animals and their ectoparasites may be true reservoirs of *R. prowazekii*.

Ovazza (M.) & Neri (P.). **Vecteurs de paludisme en altitude (région d'Addis Abeba, Éthiopie).**—*Bull. Soc. Path. exot.* **48** (1955) no. 5 pp. 679–686, 1 map, 5 refs. Paris, 1956.

Addis Ababa is situated at an altitude of over 8,000 ft., and opinions have been divided as to the occurrence of indigenous malaria and the existence of foci of Anopheline breeding there. The town and the country southwards to the Akaki hydroelectric station, some 25 miles away, are briefly described, and the observations of R. Martin and M. Giaquinto-Mira are reviewed. Martin [*R.A.E.*, B **31** 242] claimed to have proved the existence of indigenous malaria in Addis Ababa with *Plasmodium vivax* and *P. falciparum* as the parasites responsible and *Anopheles gambiae* Giles as the only Anopheline. Giaquinto-Mira maintained that *A. gambiae* did not breed above 6,500 ft. [*cf.* **26** 67, 183], though a few adults of this species and of *A. pharoensis* Theo. had been taken at Addis Ababa and *A. pharoensis* was often found infected in Ethiopia [*cf.* **28** 117]. He considered the Anopheline fauna of the town to be composed chiefly of *A. christyi* (Newst. & Cart.) and *A. cinereus* Theo., which rest indoors but rarely bite man, and possibly *A. garnhami* Edw.

The authors surveyed the town area and the area of the hydroelectric station for adults and larvae during the period 1953–55. Dwellings, garages, animal and poultry shelters and the undersides of bridges, etc., were searched for adults. Females of *A. gambiae* were taken only twice in Addis Ababa, on both occasions in the lower part of the town, near the railway station and terminal point for lorries. Cases of malaria that appeared to have been contracted locally were also from this area. No larvae of *A. gambiae* were found. *A. christyi* and *A. cinereus*, both sexes of which occurred in most types of resting place, were the species most often met with, but the females showed little tendency to bite man, and precipitin tests always gave a positive reaction for bovine blood. The larvae occurred in both natural and artificial collections of water. *A. demeilloni* Evans and *A. garnhami* were fairly common, but both tended to be rural and exophilous, particularly the latter, of which var. *walshi* Evans was found only at a certain distance from the town. Larvae of *A. demeilloni* and *A. sergentii macmahoni* Evans were found in September–November in a river in a comparatively rural area. Larvae of *A. coustani* Lav. were once found, and one was reared and gave rise to a female of var. *ziemanni* Grünb.

At the hydroelectric station (altitude 6,500–7,000 ft.) and the villages around the two artificial lakes there, cases of malaria are fairly numerous each year, and those examined were due to *P. falciparum*. The vector is probably *A. gambiae*. Adult Anophelines are present in numbers only in September–December at and immediately after the end of the rains. *A. gambiae*, *A. christyi* and *A. demeilloni* were breeding in the rocks and earth at the foot of the barrage of the main lake at this time. Other species found breeding in the area in various habitats were *A. coustani*, *A. garnhami*, *A. cinereus* and *A. squamosus* Theo. The Anopheline index in

autumn never exceeded 12 per room, of which 4–7 were *A. gambiae*, and others *A. coustani coustani* and *A. christyi*. None was found at other times. *A. christyi* did not seem to bite man readily. *A. gambiae* attacked in the open as well as indoors, and *A. demeilloni* and *A. garnhami* were also taken out of doors.

It is possible that the tepid springs of the Akaki valley and the relative shelter provided by the walls of the gorge and the hollow in which the artificial lakes are situated favoured the establishment of *A. gambiae* at this altitude. If this is so, it might indicate that the tepid springs in the lower part of Addis Ababa could occasionally allow the species to establish itself there.

Colas-Belcour (J.) & Vervent (G.). **Transmission de divers spirochètes de la fièvre récurrente par une souche soudanaise de** l'*Ornithodoros erraticus* **Lucas** (= *O. e.* **var.** *sonrai* **J. Sautet, H. Marneffe et M. Witkowsky 1944).**—*Bull. Soc. Path. exot.* **48** (1955) no. 5 pp. 747–757, 37 refs. Paris, 1956.

The problem of the specificity of the relationship between relapsing-fever spirochaetes and the ticks of the genus *Ornithodoros* that transmit them is complicated by differences in the ability of geographical races of the small form of *O. erraticus* (Lucas) to transmit different strains of *Borrelia crocidurae* [*R.A.E.*, B **44** 108–110, 201–202]. There is evidence that these races represent incipient species [**44** 110], but as some of them have been equated with *O. erraticus* var. *sonrai* Sautet & Witkowski [**41** 193], which was described from a colony of uninfected ticks found in a rodent burrow at Gao (French Sudan) [**35** 45], the authors investigated the ability of ticks of a strain reared from members of this colony to transmit four strains of *B. crocidurae* (*crocidurae* from Dakar, *merionesi* from southern Morocco, *microti* from Persia, and Qaranfil from Egypt) and also a Moroccan strain of *B. hispanica* and a strain of *B. duttoni* from the Belgian Congo. All the results, which are given in some detail, were negative except those for strains *crocidurae* and *merionesi*. Both of these were transmitted from mice to mice or rats at intervals ranging from 127 to 170–175 and 183 days, respectively, after the infecting feed, and the *crocidurae* strain was transmitted by nymphs that were the offspring of females that oviposited during the tests. In an experiment in which the ticks were isolated to compare rates of transmission, *crocidurae* was transmitted by seven out of 25 ticks and *merionesi* by six out of 25.

Sparrow (H.). **Les spirochètes des fièvres récurrentes et le pou (de l'origine des épidémies de récurrente à poux).**—*Arch. Inst. Pasteur Tunis* **32** no. 1 pp. 25–49, 20 graphs, 3 refs. Tunis, 1955.

Precise knowledge of the relationship between relapsing-fever spirochaetes and the louse [*Pediculus humanus humanus* L.], as a normal or occasional vector, might explain the reappearance of epidemics of louse-borne relapsing fever (caused by *Borrelia recurrentis*) after long intervals. The whole of North Africa was involved in a typical louse-borne epidemic in 1943–46, and the development of infection was followed in lice fed on patients. It was established that a single feed during the attack of fever is enough to infect lice. The ingested spirochaetes disappeared from the contents of the intestinal tract within a few hours and appeared simultaneously in the body fluid where they increased rapidly if the lice were kept under optimum conditions. They continued to multiply throughout the life of the louse,

which was not shortened. The excreta of the lice did not contain spirochaetes, and the infection was not hereditary in lice. Attempts to infect small laboratory animals by injection of spirochaete-rich material from lice were unsuccessful. Attempts to transmit the disease by the bites of infected lice to patients needing relapsing-fever therapy also failed, but it was readily transmitted by placing haemocoelic fluid on the scarified skin. When so produced, it was the same in character as when naturally acquired. The spirochaetes remained virulent for as long as the lice lived.

When the epidemic died out at the beginning of 1947, and *B. recurrentis* was not available to infect patients, use was made of the Langeron strain of tick-borne hispano-moroccan relapsing fever [a Moroccan strain of *B. hispanica*, of which the vector is *Ornithodoros erraticus* (Lucas)]. The required strong reaction was produced by injecting the blood of heavily infected passage animals. Some lice acquired infection [*cf. R.A.E.*, B **14** 194] by feeding on patients during the first attack of fever, but the percentages that did so (1–10 or rarely up to 30) and the intensity of infection were always lower than those obtained in the same conditions with *B. recurrentis*. They depended on the number of infective meals and the density of spirochaetes in the blood. The spirochaetes persisted and remained infective for man and animals throughout the natural life of the lice. They also remained infective through 23 passages by injection from louse to louse.

Six strains of the hispano-moroccan type were isolated by inoculation of blood from naturally infected people into susceptible animals and by infection of lice fed on these people. One of them, proved to be of this type by pathogenicity and cross-immunity with the Langeron strain, was isolated in 1950 and was abnormal in that the lice developed infection as intense as that seen with *B. recurrentis*. The peculiar character of the strain remained constant through numerous passages in man, animals and lice. There were even clear cases of the development of infection in lice that had fed on patients with attenuated or inapparent infections. A case of mutation of the Langeron strain is also described. A patient inoculated with this strain had four attacks of fever, the first and third typical and the second and fourth atypical. The patient's blood was infective for guineapigs during the first attack, but not during the third. Guineapigs inoculated with blood taken during the fourth attack remained negative until they died on the twelfth day. Blood taken at the same time and inoculated into another patient caused a similar irregular infection. The mutant strain remained highly infective for lice and for patients inoculated with lice, and caused only inapparent infections in guineapigs and attenuated infections in rats. These characters were constant. These two cases provide support for the theory originally put forward by Nicolle & Anderson [**14** 168] that epidemic louse-borne relapsing fever originates in the infection of lice with tick-borne spirochaetes.

Brygoo (E. R.) & Escolivet (J.). **Enquête sur la filariose aux Comores, à Mayotte et Mohéli.**—*Bull. Soc. Path. exot.* **48** (1955) no. 6 pp. 833–838, 4 refs. Paris, 1956.

Filariasis caused by *Wuchereria bancrofti* has long been known to be present in the Comoro Islands. Surveys involving about 14 and 50 per cent. of the adult populations of Mayotte and Moheli showed microfilaria rates of 48 and 48·7 per cent., respectively, in males and 26·7 and 38 per cent. in females. The rates increased with age. The microfilariae had a marked nocturnal periodicity.

Anopheline surveys in 1954 and limited investigations, aimed at finding

filaria vectors in June 1955, showed that *Anopheles gambiae* Giles, *A. funestus* Giles, *A. coustani* Lav., *A. pretoriensis* (Theo.), *Aëdes aegypti* (L.), *A. simpsoni* (Theo.) and *Eretmapodites quinquevittatus* Theo. were present on both islands, *Ficalbia* (*Ravenalites*) *roubaudi* (Doucet) on Mayotte, and *Anopheles squamosus* Theo., *A. marshallii* (Theo.), *A. pauliani* Grjebine, *Aëdes albocephalus* (Theo.), *Culex pipiens fatigans* Wied., *C. simpsoni* Theo. and *Eretmapodites subsimplicipes* Edw. on Moheli. It is recalled that *Anopheles gambiae*, *A. funestus* and *C. p. fatigans* are known vectors of *W. bancrofti* elsewhere.

Maillot (L.) & Taufflieb (R.). **Présence de *Glossina nashi* Potts 1955 en Afrique équatoriale française.**—*Bull. Soc. Path. exot.* **48** (1955) no. 6 pp. 847–848, 1 ref. Paris, 1956.

A male and a female of *Glossina* of the group of *G. fusca* (Wlk.) taken in the Nola district of Ubangi-Shari in May 1953 and a female taken in the M'Vouti district of Middle Congo in July 1955 were found to be examples of *G. nashi* Potts, recently described from the British Cameroons [*R.A.E.*, B **45** 23]. Both districts are in regions of heavy forest, where other species present are *G. tabaniformis* Westw., *G. haningtoni* Newst. & Evans and *G. newsteadi* Aust.

Gasser (R.) & Wyniger (R.). **Beitrag zur Kenntnis der Verbreitung und Bekämpfung von Trombiculiden, unter spezieller Berücksichtigung von *Trombicula autumnalis* Shaw.** [Contribution to Knowledge on the Distribution and Control of Trombiculids, with special Reference to *T. autumnalis*.]—*Acta trop.* **12** no. 4 pp. 308–326, 2 figs., 59 refs. Basle, 1955. (With Summaries in French & English.)

The literature on the control of Trombiculids is briefly reviewed, data are given on the local distribution and ecology of *Trombicula autumnalis* (Shaw), in the neighbourhood of Basle (mainly in Switzerland), and experiments with a spray and a repellent against the larvae are described. The spray was prepared by diluting an emulsion concentrate (Geigy 338) containing 25 per cent. chlorobenzilate (ethyl 4,4′-dichlorobenzilate), and the repellent was Kik [of which the active ingredient is a mixture of N,N-diethyl benzamide and o-chloro-N,N-diethylbenzamide].

In the laboratory, petri dishes were sprayed with chlorobenzilate at three concentrations, and the Trombiculid larvae were exposed on the dried deposit. The necessary humidity was provided by a damp filter paper. The mites were incapable of movement within 90, 50 and 30 minutes when the chlorobenzilate was applied at concentrations of 0·025, 0·05 and 0·125 per cent., respectively, and all were dead after 16 hours, when mortality in unsprayed dishes was 30 per cent. In further tests, a direct mist spray of 0·05 per cent. chlorobenzilate rendered all the larvae incapable of movement in 12 minutes. In a field test, two heavily infested plots were sprayed at rates giving 10 and 20 gm. chlorobenzilate per are [120 sq. yards] and a third was left as a control. The mites remained numerous and active on the control plot for four days after the sprays were applied, but none could be found on the treated plots on the first two days and very few on the third and fourth. Cool, rainy weather then ended the activity of the mites on all three plots.

In the tests with Kik, several persons wearing ankle socks stood, with the lower parts of the legs uncovered, around a compost heap known to be the seat of the infestation. The mites crawled indiscriminately on to both

untreated legs and legs treated with 2 cc. Kik, but those on treated skin moved only with difficulty after 3–4 minutes and fell to the ground dead after 7–8 minutes. No reduction in the effectiveness of the application was observed within 5 hours. Effective protection has also been reported by numerous persons who have used Kik in infested areas. Its acaricidal action was confirmed by tests in which contact with treated skin for 40–60 seconds was lethal to the mites. It is thought that Kik would be as effective on stockings as on skin and would be of value against the Trombiculids that transmit tsutsugamushi disease, since it has been shown that a compound that immobilises Trombiculids in 15 minutes on treated cloth may be expected to afford 90 per cent. protection against them. [*R.A.E.*, B **38** 30].

Ratcliffe (F. N.). **Review of Myxomatosis in Australia, 1950–1955.**—*J. Aust. Inst. agric. Sci.* **21** no. 3 pp. 130–133, 1 ref. Sydney, 1955.

Sobey (W. R.). **Changes in the innate Resistance of Rabbits to Myxomatosis.**—*T. c.* pp. 135–136, 3 refs.

Fenner (F.). **Changes in the Virulence of Myxoma Virus associated with its natural Transmission in Populations of the Rabbit** *Oryctolagus cuniculus*.—*T. c.* pp. 137–144, 2 graphs, 6 refs.

Day (M. F.). **Factors influencing the Transmissibility of Myxoma Virus by Mosquitoes.**—*T. c.* pp. 145–151, 3 figs., 6 refs.

Myers (K.). **The Ecology of the Mosquito Vectors of Myxomatosis (*Culex annulirostris* Skuse and *Anopheles annulipes* Walk.) in the eastern Riverina.**—*T. c.* no. 4 pp. 250–253, 2 graphs, 2 refs.

The status and vectors of myxomatosis in eastern Australia [*cf. R.A.E.*, B **45** 167, etc.] are reviewed in the first paper. The disease has greatly reduced rabbit populations in the eastern half of the continent since 1952, its distribution is virtually co-extensive with that of the rabbit, and it has remained enzootic everywhere. Field studies have emphasised the importance of mosquitos as vectors. Simuliids are the only other insects known to play a considerable part in transmission; they seem to have been solely or mainly responsible for some localised outbreaks during spring and autumn, but are chiefly important in disseminating infection over long distances. Recoveries of virus from mass collections of mosquitos in the coastal and near-coastal belts have shown that several species may be involved in transmission, either simultaneously or serially, but *Culex annulirostris* Skuse and *Anopheles annulipes* Wlk. are the chief vectors over much of New South Wales and Victoria. *C. annulirostris* appears to be sensitive to low atmospheric humidity and rarely ranges far beyond the tree belt fringing rivers and swamps, except in unusually damp seasons. In a normal year, it may produce epizootics of high intensity but limited extent. *A. annulipes* is well adapted to existence in areas of erratic rainfall, being relatively insensitive to low humidities, widely ranging and long-lived. Its importance is increased by its habit of sheltering in rabbit burrows, not only in hot, dry weather but also in periods of continuous rain or drizzle. From knowledge of the requirements of these species in terms of rainfall, the incidence of myxomatosis can be forecast in areas where they are the main vectors.

Continued effective rabbit control depends on the maintenance of high kills. The case mortality rate has fallen from over 99 to about 90 per cent. With a further fall to about 80 per cent., the disease would virtually cease to effect control. Brief reference is made to the possibility of maintaining a virulent type of infection in the field by deliberate inoculations with a fully virulent strain. It is suggested that myxomatosis may not be solely

responsible for the present decrease of the rabbit in south-eastern Australia but that it may have been working in a population in process of a natural temporary decline.

In the second paper, the possibility is examined that a resistant strain of rabbits is being genetically selected. Laboratory experiments in progress in Sydney indicate some degree of genetic control over resistance, and studies of the susceptibility of rabbits born in sections of the population that have undergone different numbers of epizootics have indicated that mortality will fall to 50 per cent. in another 5–10 epizootics. In view of this, the continued release of fully virulent strains at a high rate is advocated.

The relative virulence of different strains of the virus recovered in the field in Australia, America and Europe and possible changes in the host-virus balance in Australia are discussed in the third paper. It is thought that even in the absence of further deliberate introduction, the virus could be eliminated from Australia only by elimination of the host. The present balance (a dominant field strain killing about 90 per cent. of infected rabbits with negligible change in innate resistance in the rabbit) is highly effective, but a small reduction in the case mortality rate and an occasional season with few vectors could allow of a great rise in rabbit numbers.

Experiments described in the fourth paper showed that a field strain (KM13) from New South Wales, another (Lausanne) from Switzerland and the standard laboratory strain were acquired and transmitted by *Aëdes aegypti* (L.) with about equal effectiveness, but that KM13, which allows the rabbits to survive longer, could replace Lausanne in the field. This is almost certainly connected with the length of time that lesions remain infective to mosquitos. Although mosquitos carry the virus mechanically, experiments with *A. aegypti* and *Anopheles annulipes* and a few observations on *Aëdes alboannulatus* (Macq.) showed that the species differ in their efficiency as vectors, probably owing to differences in the structure of their mouth-parts. A blood-meal on an immune rabbit immediately after an infective meal (instead of a blood-meal on a healthy one) had no effect on the ability of a mosquito to transmit the infection at subsequent meals. Doses of Murray Valley encephalitis of the size injected by a mosquito had no influence on the course of myxomatosis in rabbits when the two viruses were inoculated simultaneously.

An account is given in the fifth paper of intensive investigations begun in 1953 to determine the reasons for differences in the epidemiology of the disease in three parts of the eastern Riverina in New South Wales (a section of the plains abutting Lake Urana, a foothill valley and about a square mile of river-flats). Two species of mosquitos, *Anopheles annulipes* and *Culex pipiens australicus* Dobr. & Drum., were found to rest in rabbit burrows, and 5 per cent. of the former but none of the latter were freshly engorged with rabbit blood when they emerged at dusk and 20 per cent. of the former and 0·5 per cent. of the latter when they entered after dawn. *C. annulirostris* also attacked the rabbits outside at night. The rate of myxomatosis transmission was high at the time, and it was shown under similar circumstances that both *C. annulirostris* and *A. annulipes* were carrying the virus. *C. p. australicus*, though present in large numbers and giving positive reactions for rabbit blood in precipitin tests, was evidently of little importance. A comparison of production of *C. annulirostris* and *A. annulipes* with rainfall in the Urana area from November 1953 to June 1955 showed that *C. annulirostris* responded immediately to the three big peaks in rainfall, which all occurred in the warm months, and that *A. annulipes* responded to the rainfall peaks and also used increased surface water in early spring and waters remaining in the autumn of 1954. Fluctuations in adult activity were closely correlated with the five peaks in mosquito production, except for an unexpected peak in activity in November 1954. In the

case of *C. annulirostris*, this was almost certainly due to rather early renewal of activity of a relatively large overwintering adult population, and in that of *A. annulipes* was attributed to sudden interest in rabbits or the shelter of their burrows on the part of overwintered adults or adults produced in winter and spring. Disease incidence closely followed mosquito activity. The sequence of the epizootics in the study areas on the river-flats and in the valley contrasted strongly in details with that on the plains, but reinforced the conclusion that variations in disease activity from place to place and year to year reflect the different ways in which the habitats and vectors respond to rain.

Moule (G. R.), Young (R. B.) & McFarlane (B. D.). **Field Observations on the Prevention of Breech Strike in Merino Sheep by Jetting with Aldrin, BHC, Dieldrin and Endrin.**—*Qd J. agric. Sci.* **12** no. 4 pp. 101–106, 6 refs. Brisbane, 1955.

Interest in jetting to prevent blowfly strike in sheep in Australia has revived since the chlorinated-hydrocarbon insecticides were shown to confer protection [*R.A.E.*, B **37** 2; **41** 196; **42** 20–22]. An account is given of observations made in autumn in 1954 and 1955 on the comparative value of aldrin, BHC, dieldrin and endrin in the control of breech strike by jetting. Four groups of Merino lambs 5–7 months old were used in the first season. None had been shorn, crutched or subjected to Mules' operation [**32** 142] or the tail strip operation [**37** 2], but the tails of the ewe lambs had been cut level with the tip of the vulva [*cf.* **37** 1]. On 19th February, about 2 quarts of a 0·1 per cent. solution of aldrin, dieldrin or BHC was jetted into the wool of the breech and along the back of each sheep of three of the groups, and the fourth group was kept as an untreated control. The animals were examined once a week for three months. In this time, strike developed (larvae established themselves) on 15 of 55 ewe lambs (and 6 of 59 wethers) treated with aldrin, 16 of 59 (1 of 57) treated with dieldrin, 46 of 58 (2 of 55) treated with BHC, and 40 of 65 (4 of 49) controls. Breech strike in sheep treated with aldrin and dieldrin reached a similar level to that in the controls by the sixth week after treatment. In 1955, four groups of 100 uncrutched Merino lambs 3–4 months old, each containing 50 ewes, were treated as in the previous year's experiment with 2 quarts 0·05 per cent. aldrin, dieldrin or endrin or left untreated. Larvae developed on 13 of the ewes treated with aldrin, 6 of those treated with dieldrin, 9 of those treated with endrin and 28 on the controls. No strike developed in those treated with dieldrin or endrin until the ninth week, after which time the rate was as high as that in the controls. There was practically no oviposition or strike on treated or untreated wethers.

Emerson (K. C.). **Mallophaga (Chewing Lice) occurring on the domestic Chicken.**—*J. Kans. ent. Soc.* **29** no. 2 pp. 63–79, 33 figs., 28 refs. Manhattan, Kans., 1956.

A list, showing synonyms and including notes on prevalence and world distribution, is given of the Mallophaga that infest domestic fowls, together with a key for their identification. Both sexes and the male genitalia of the forms known or likely to occur in the United States are figured. These include *Menacanthus cornutus* (Schömmer), which had not previously been recorded from the United States, though the author found it in abundance on farm flocks of fowls in Oklahoma and the U.S. National Museum has material collected in Alabama, and *M. pallidulus* (Neum.),

which is shown by the Museum material to be common throughout the United States, though it has seldom been recorded there because it has frequently been misidentified as the immature form of *M. stramineus* (Nitzsch).

Shura-Bura (B. L.), Ivanova (E. V.), Onuchin (A. N.), Glazunova (A. Ya.) & Shaĭkov (A. D.). **Ways of Fly Dispersion from Places of Mass Breeding in Leningrad.** [*In Russian.*]—*Rev. Ent. URSS* **35** pt. 2 pp. 334–346, 3 figs., 11 refs. Moscow, 1956.

The range of dispersal of flies from a garbage dump situated about half a mile from densely inhabited districts of Leningrad was studied between 22nd June and 25th July 1954. Identification of 2,000 adults taken on the dump in June showed that *Phormia* (*Protophormia*) *terraenovae* R.-D., *Musca domestica* L., *Muscina stabulans* (Fall.) and *Lucilia caesar* (L.) constituted 82·5, 12·8, 2·0 and 0·5 per cent. of the population. Dishes of a bait consisting of a liquid mixture of sugar, yeast, flour and water, with the addition of 10 per cent. meat paste and enough radioactive phosphorus as sodium phosphate to give a radioactivity of 1·8 mc. per lb. were exposed for four days on the dump, and it was found that about 8 per cent. of the first two species were rendered radioactive. Traps were subsequently operated at various distances from the dump, and radioactive examples of *P. terraenovae*, *Musca domestica*, *Muscina stabulans* and *L. caesar* were taken at distances ranging up to 2·86, 2·4, 1·3 and 2·86 miles, respectively. Dispersion occurred in all directions, but inhabited districts were the most attractive. It was mainly due to active flight, though many flies were carried for up to about five miles on vehicles.

Petrova (R. G.). **Contribution to the Study of Tabanid Species and their seasonal and Day Activity in the Province of Astrakhan (Diptera, Tabanidae).** [*In Russian.*]—*Rev. Ent. URSS* **35** pt. 2 pp. 359–370, 5 figs., 8 refs. Moscow, 1956.

The Tabanids that attack cattle and horses in the north of the Volga delta were studied from mid-June to mid-September 1953 in a pasture situated on one of the tributaries of the river and on an island covered with forest. The chief factor that affects their seasonal abundance is the annual flood, which usually occurs at the end of April or beginning of May, but was late in 1953. A few adults may emerge before the flood, but mass emergence does not begin until the water level has fallen. Eight species were found attacking domestic animals; the most numerous were *Tabanus autumnalis* L. and *T. nigrivitta* Olsuf'ev in the pasture and *Chrysops relictus* Mg. and *C. flavipes* Mg. on the island. The author was informed that some adults had emerged in the pasture in May, but none appeared after the flood until the end of June and considerable flights were not observed until the beginning of July. Peak flight was in mid-July, when up to 30–40 examples were collected from a cow in 15 minutes. The Tabanids were much less abundant in the second half of July, when dragonflies and wasps of the genus *Bembix* preyed on them in numbers, and they disappeared at the end of July, their flight period and the period of intensive attacks having lasted 40–45 and 20–25 days, respectively. On the island, the flight began on 3rd July and the flight period and period of intensive activity lasted 46 and about 30 days, respectively. The flight periods of the individual species are given in a table.

The Tabanids were active under favourable conditions from 6–7 a.m. to 9–10 p.m., peak activity occurring at 8–10 a.m. and 4–9 p.m. No activity

was observed below 20°C. [68°F.], but a vigorous attack took place at 37°C. [98·6°F.], the highest temperature recorded. Activity was little affected by relative humidity or by wind velocities of up to 4·4 miles an hour, but was considerably reduced when the wind was 5·6 m.p.h., and inhibited when it was at 10–20 m.p.h.

Galuzo (I. G.) & Rementsova (M. M.). **Vectors and Reservoirs of Brucellosis Infection in Nature.** [*In Russian.*]—*Rev. Ent. URSS* **35** pt. 3 pp. 560–569, 62 refs. Moscow, 1956. (With a Summary in English.)

Instances of the recurrence of brucellosis in livestock in various parts of the Soviet Union after previously infected animals had been removed from the farms concerned, and also the finding of naturally infected ticks there [*cf. R.A.E.*, B **35** 112, 159; **43** 145; **44** 148, 149] confirm the view that this is a disease to which the theory of natural nidality applies [**44** 146]. Records (showing the authority in each case) are cited of the arthropods and wild vertebrates that have been found naturally infected or have been infected experimentally by Russian workers, and of the finding of natural infection in *Aëdes aegypti* (L.) in Malta and *Culex pipiens* L. in Malta, Sicily and Kazakhstan. The other arthropods found naturally infected are all ticks and comprise *Ornithodoros lahorensis* Neum., *Boophilus calcaratus* (Bir.), two species of *Hyalomma*, three of *Haemaphysalis* and three of *Dermacentor*, and those infected experimentally include two additional species of *Hyalomma*, *O. tholozani* (Lab. & Mégn.) (*papillipes* (Bir.)), *Argas persicus* (Oken), *Musca domestica* L., *Neopsylla setosa* (Wagn.) and *Ceratophyllus tesquorum* Wagn. The experimentally infected vertebrates include cold-blooded animals, but all those found naturally infected are mammals and birds and most of them are rodents.

Kheĭsin (E. M.) & Lavrenenko (L. E.). **Duration of Blood-sucking and daily Rhythm of Feeding and Dropping in Females of *Ixodes ricinus* L.** [*In Russian.*]—*Zool. Zh.* **35** pt. 3 pp. 379–383, 15 refs. Moscow, 1956. (With a Summary in English, suppl. p. 6.)

Details are given of investigations in the Karelo-Finnish Republic in 1953 on the duration of feeding on cattle and the daily rhythm of dropping of engorged females of *Ixodes ricinus* (L.). The results were very similar to those recorded for *I. persulcatus* Schulze [*R.A.E.*, B **43** 146–147] and showed that dropping occurs while the cattle are out at pasture, whether by day or by night, and not while they are in the sheds, where they were kept in some cases for up to two days. Engorgement was completed on the seventh or eighth day after attachment, the amount of blood ingested increasing greatly during the night preceding dropping. It is therefore concluded that treatments for the control of ticks should be applied in the evening, so as to prevent them from completing engorgement during the night and dropping in the pasture and possibly ovipositing on the following day.

Grunin (K. Ya.) & Doszhanov (T. N.). **A Method of individual Recording of the Duration of Development in Warbles of the Larvae of the Ox Warble Flies.** [*In Russian.*]—*Zool. Zh.* **35** pt. 3 pp. 400–405, 3 figs., 2 refs. Moscow, 1956. (With a Summary in English, suppl. p. 9.)

Economical control of *Hypoderma bovis* (Deg.) and *H. lineatum* (Vill.) in the backs of cattle depends on a knowledge of the duration of development

of the larvae in the warbles, and this varies with the age and state of nourishment of the host and, in mountainous regions, with altitude. The authors describe a method of ascertaining it for a given herd by covering the warbles on selected animals with small caps as soon as they appear and recording the dates of appearance of the warbles and issuance of the larvae from them. The animals selected should be representative of various age groups and in both good and bad nutritional condition. An average figure can thus be obtained for the herd as a whole or for any section of it.

Sukhomlinova (O. I.). **Contribution to the seasonal Biology of the Common Malaria Mosquito (*Anopheles maculipennis* Mg.) under the Conditions of the Province of Leningrad.** [*In Russian.*]—*Zool. Zh.* **35** pt. 3 pp. 406–411, 2 graphs, 10 refs. Moscow, 1956. (With a Summary in English, suppl. pp. 9–10.)

Investigations were carried out in 1952–53 at Pavlovsk, in the province of Leningrad, on seasonal changes in the population of adult females of *Anopheles maculipennis* Mg., with a view to detecting their possible importance as vectors of malaria. It was established by examination of egg-batches in 1951 that *A. m. messeae* Fln. and *A. m. maculipennis* constituted 56 and 44 per cent. of the population, respectively. Females were collected in cattle sheds and uninhabited rooms and their physiological age determined by counting the dilations on the ovarioles, which indicate the numbers of times that oviposition has occurred. Fluctuations in 1952 in the numbers of females that had not yet oviposited and had done so once showed three peaks, on 17th June, 12th July and 12th August, thus indicating the development of three generations, and this was in agreement with counts of first-instar larvae in neighbouring breeding places. The overwintered females were long-lived, surviving until mid-June, and completed up to six gonotrophic cycles, but most of them died before malaria parasites could have completed development in them at the temperatures prevailing. First-generation females were present from early June until about the end of July and completed up to seven gonotrophic cycles in 1952 and 12 in 1953. Examples that could have become infective were present by 26th June and most numerous from 28th July to 10th August. Diapausing females were observed from mid-July.

Hurtig (H.), Mann (S. L. W.), Hopewell (W. W.) & Gravells (R.). **A new Technique for sampling and assessing aerial Spray Deposits.**—*Canad. J. agric. Sci.* **36** no. 2 pp. 81–94, 1 pl., 2 graphs, 8 refs. Ottawa, 1956.

The following is almost entirely the authors' abstract. Printflex paper cards (glossy white cards sized with casein and finished with a mixture of calcium sulphate and calcium carbonate) were found to provide a satisfactory surface for collecting samples of aerial sprays for the assessment of spray deposits. The spread factor for an oil solution of an insecticide on them is not constant for the various droplet sizes, and the factors for dyed and undyed solutions of DDT in oil, on undyed and dyed paper, ranged from 3·6 to 6·2 for corresponding stains produced by droplets in the range 60 to 600μ. A new rapid photographic method of quantitative assessment of the deposit on the cards is described, in which a high-contrast, light-weight photographic paper is used instead of film. The process provides a permanent record of the stains, enlarged 3·5×, with a suitable calibration grid recorded on the print. The assessment can be carried out without any

further optical aids. Statistical analysis showed that density of deposit, number of droplets per unit area, and mass median diameters of the spray sample can be determined with a high degree of accuracy by these methods. In two field trials, they were found to be comparable in accuracy with other sampling and assessment methods.

Goodwin-Bailey (K. F.), Holborn (J. M.) & Davies (M.). **A Technique for the biological Evaluation of insecticidal Aerosols.**—*Ann. appl. Biol.* **45** no. 2 pp. 347–360, 1 pl., 7 refs. London, 1957.

An account is given of a technique for the biological evaluation of insecticidal aerosols produced from pressure dispensers. Six aerosol solutions were tested against free-flying and caged flies (*Musca domestica* L.), and the effectiveness of each was judged on the time needed to paralyse half the flies (KD50c [*R.A.E.*, B **38** 26]) and on the percentage kill obtained in 24 hours. Statistical analysis of some of the estimated figures for KD50c showed a standard error of 4·5 per cent. of the mean. The effects of temperature, and of distribution and dosage of the aerosol on the results were investigated. Free-flying flies were preferred, mainly because of better replication of results.

The standard technique adopted was to discharge the aerosol at 3 gm. solution per 1,000 cu. ft. into a test chamber with a capacity of 1,194 cu. ft. by walking through the room with the dispenser held above the head. The walls and ceiling of the room were treated with white, flat solvent-resisting enamel, and the floor was freshly covered with brown, absorbent paper before each test. Illumination was by fluorescent lighting with an intensity of 10 f. c. measured 3 ft. above the floor, and temperature and relative humidity were maintained at 80 ± 2°F. and 50 ± 1 per cent. The test insects (adults of *M. domestica* 4–6 days old, bred by a method that is described in detail) were released from bags at floor level immediately after the discharge of the aerosol and exposed for 10 minutes. The room was then ventilated, and the flies were collected by gentle suction and kept at 80 ± 2°F. in glass jars for the observation period of 24 hours. They were provided with 5 per cent. sugar solution absorbed in cotton-wool. Suggestions are made for the practical application of the technique.

Barbesgaard (P.) & Keiding (J.). **Crossing Experiments with Insecticide-resistant House Flies** (*Musca domestica* **L.**).—*Vidensk. Medd. dansk naturh. Foren.* **117** pp. [3+] 84–116, 8 figs., 32 refs. Copenhagen, 1955.

The following is substantially the authors' summary. The object of the work described was to investigate the inheritance of resistance to DDT, BHC and chlordane in *Musca domestica* L. Two Danish resistant strains were used of which one was resistant to all three insecticides and the other to DDT only. Reciprocal pair crosses to a susceptible strain were carried out after the two resistant strains had been selected for resistance to the insecticides in question in order to make them highly resistant. A simple breeding and testing procedure is described. The criterion of resistance was the knockdown time by continuous exposure to deposits of the insecticides. The results, which are presented as histograms, do not indicate any influence of cytoplasmic or sex-linked factors on the inheritance of resistance. They suggest that the DDT-resistance of the multi-resistant strain depends on a single recessive gene, while several genes seem to be responsible for its BHC-resistance and perhaps also for its chlordane-resistance. The results

for the experiments involving the strain resistant to DDT only are rather inconclusive, but suggest that the resistance in this case is determined by more than one gene.

Beroza (M.). **Identification of 3,4-Methylenedioxyphenyl Synergists by Reversed-phase Paper Chromatography.**—*Analyt. Chem.* **28** pp. 1550–1552, 3 figs., 14 refs. Easton, Pa., 1956.

The following is the author's summary. Insecticide synergists or other compounds containing the 3,4-methylenedioxyphenyl group can be identified in the 2- to 10-γ range by chromatography on paper strips impregnated with paraffin oil, with 30 per cent. acetic acid as the developing solution. The position of the compound on the strip is determined by direct spectrophotometry; the difference in absorbence at two wave lengths, corresponding to a high and low absorbence value of the synergist, is used. This eliminates fluctuations in absorbence due to irregularities of the paper, but shows up the large absorbence differences of the synergists. The procedure also reduces interference from other materials usually present in insecticide formulations.

Gersdorff (W. A.), Piquett (P. G.) & Beroza (M.). **Comparative synergistic Effects of synthetic 3,4-Methylenedioxyphenoxy Compounds in Pyrethrum and Allethrin Fly Sprays.**—*J. agric. Fd Chem.* **4** no. 10 pp. 858–862, 12 refs. Easton, Pa., 1956.

The following is partly based on the authors' conclusions. In tests against *Musca domestica* L. by the turntable method [*R.A.E.*, B **26** 246], 42 of 63 synthetic 3,4-methylenedioxyphenoxy derivatives [**45** 73] were found to act as synergists with either pyrethrins or allethrin and one with pyrethrins only. Two related compounds showed no synergism. Certain ethers, acetals, and esters of aromatic sulphonic acids had a strong synergistic effect, whereas esters of carboxylic and carbamic acids had little or no effect. The presence of 18 of the compounds at a synergist:toxicant ratio of 10:1 raised toxicity to at least six times the level expected for pyrethrins alone or three times that expected for allethrin alone, so that these compounds approach the effectiveness of the best commercial synergists [**40** 59; **41** 101; **44** 19], and further work on them is considered to be warranted. At the concentrations tested, knockdown of flies in 25 minutes was complete with all sprays containing the insecticides. Sprays containing the test compounds alone caused negligible knockdown and mortality or none.

Claborn (H. V.), Radeleff (R. D.), Beckman (H. F.) & Woodard (G. T.). **Malathion in Milk and Fat from sprayed Cattle.**—*J. agric. Fd Chem.* **4** no. 11 pp. 941–942, 2 refs. Easton, Pa., 1956.

The following is virtually the authors' summary. Experiments have indicated that a spray containing 0·5 per cent. malathion is effective against various pests of livestock, and can be safely applied, even to calves [*R.A.E.*, B **45** 31]. However, before it could be recommended for use on cattle, it was necessary to determine whether it would contaminate meat or milk. Hereford cattle were sprayed 16 times at weekly intervals with 0·5 per cent. malathion. Fat samples taken a week after the last spraying contained no detectable amounts of the insecticide. When dairy cows were sprayed with 0·5 and 1·0 per cent. malathion, the insecticide was present in all milk samples taken five hours after spraying, at concentrations ranging from

0·08 to 0·36 parts per million. Only traces were present 24 hours after spraying, and samples taken three and seven days after spraying showed none.

Hornstein (I.). **Use of Granulated Zinc Columns for determining Chlorinated Organic Insecticides.**—*J. agric. Fd Chem.* **5** no. 1 pp. 37–39, 7 refs. Easton, Pa., 1957.

The following is the author's summary. As a measure of the insecticide present, the chlorine content of chlorinated organic insecticides is often determined. A simple procedure has been developed for the partial or complete removal of the organically bound chlorine as chloride ion by the percolation of an acidified solution of the insecticide through a granulated-zinc column. The fraction of the chlorine removed as chloride ion is a function of the molecular structure of the compound and is a reproducible value for a given insecticide. The chloride ion liberated is determined by potentiometric titration with silver nitrate. Applied to formulations and technical products, the procedure has a degree of specificity not available in analyses dependent on total chlorine determinations.

Hornstein (I.). **Colorimetric Determination of Toxaphene.**—*J. agric. Fd Chem.* **5** no. 6 pp. 446–448, 2 graphs, 3 refs. Easton, Pa., 1957.

The following is virtually the author's summary. A method has been developed for determining as little as 0·5 mg. toxaphene or 0·25 mg. Strobane [a chlorinated mixture of α-pinene isomers] in 5 ml. solution, and has been applied to toxaphene added to extracts of lucerne and butterfat. In tests with other chlorinated insecticides, interferences were encountered only with chlordane and heptachlor.

Jacobson (M.). **Constituents of *Heliopsis* Species. V. Heliopsin, a second Insecticidal Amide from the Roots of *H. helianthoides* var. *scabra*.**—*J. Amer. chem. Soc.* **79** pp. 356–358, 5 refs. Easton, Pa., 1957.

The following is virtually the author's summary of this paper, which belongs to a series [*cf. R.A.E.*, B **44** 111, etc.]. Heliopsin, an unsaturated isobutylamide closely related to scabrin [**40** 15], has been isolated from the roots of *Heliopsis helianthoides* var. *scabra* (formerly *H. scabra*). It is a powerful sialagogue, and is as toxic as pyrethrins to house-flies [*Musca domestica* L.]. Hydrogenation, hydrolysis, oxidation, and ultraviolet and infrared absorption spectra of heliopsin show it to be the N-isobutylamide of either 2,4,8,10,12,16- or 2,4,8,12,14,16-octadecahexaenoic acid. The geometrical configuration of heliopsin has been partially determined.

Jacobson (M.). **The Structure of Spilanthol.**—*Chem. & Ind.* 1957 pp. 50–51, 8 refs. London, 1957.

The structure of spilanthol, the insecticidal constituent of the flower heads of *Spilanthes* spp. [*cf. R.A.E.*, A **42** 228], is shown to be N-isobutyldeca-2,6,8-trienamide, and so is identical with that of affinin [B **36** 22–23]. Infrared spectra of spilanthol and of a sample of affinin obtained from roots of *Heliopsis longipes* were superimposable, and both materials gave the same high knockdown and kill in tests against house-flies [*Musca domestica* L.] and larvae of *Anopheles*.

Papers noticed by Title only.

Abonnenc (E.). **Sur un anophèle cavernicole de la Guinée: *Anopheles cavernicolus* n. sp. (Diptera-Culicidae) (Note préliminaire).**—*Bull. Mém. École prép. Méd. Pharm. Dakar* **2** (1954) pp. 288–290, 2 figs., 5 refs. Dakar, 1955. Also in *Bull. Inst. franç. Afr. noire* **18** no. 3 pp. 802–805, 2 figs., 5 refs. Dakar, 1956.

Lips (M.) & Hamon (J.). **Contribution à l'étude des culicidés (diptères) de la région éthiopienne. Description de la larve, de la nymphe et du mâle d'*Anopheles austeni* Theobald 1905** [from Katanga].—*Bull. Soc. Path. exot.* **48** (1955) no. 6 pp. 872–882, 6 figs., 2 refs. Paris, 1956.

Grenier (P.), Hamon (J.) & Rickenbach (A.). **Simuliidae d'Afrique occidentale française (Haute-Volta, Dahomey, Soudan français, Sénégal, Côte d'Ivoire).**—*Bull. Soc. Path. exot.* **48** (1955) no. 6 pp. 885–891, 1 fig., 3 refs. Paris, 1956.

Metcalf (R. L.). **Physiological Basis for Insect Resistance to Insecticides** [a review article].—*Physiol. Rev.* **35** no. 1 pp. 197–232, 2 figs., 191 refs. Baltimore, Md., 1955.

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